TSUNAMI CASUALTIES AND MORTALITY IN HAWAII

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ABSTRACT

Seven tsunamis are known to have caused fatalities in Hawaii. For several of these tsunamis, different numbers of fatalities have been reported in different publications of kinds that are commonly used as references. To determine which of the numbers reported for each tsunami is correct, or at least to determine the most probable number of fatalities caused by each, recourse has been made to contemporary sources of information.

The results are as follows:

Tsunami	Number (or most probable number) of fatalities
November 1837	16
April 1868	47
May 1877	5
February 1923	1
April 1946	159
May 1960	61
November 1975	2
Total	291

From a comparison between numbers of persons reported injured by tsunamis and the numbers of fatalities reported for the same tsunamis, it is concluded that the average ratio between persons with injuries severe enough to warrant hospitalization and fatalities has been about one.

It is estimated that the potential tsunami mortality rate in Hawaii, that is the long-term average rate at which deaths due to tsunamis would occur in the absence of protective means such as tsunami warnings, is about 0.01 per thousand de-facto population per year.

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INTRODUCTION

Motivation for study and nature of report

To estimate the effectiveness of a scheme for minimizing the casualties caused by tsunamis, it is necessary to have a quantitative estimate of the risk posed by tsunamis in the absence of the scheme. An estimate of the risk in Hawaii has been made in the form of numbers of tsunami-caused fatalities and other casualties expectable per unit population per unit time in the absence of special protective measures (Cox, 1984). The estimate was, of necessity, based on the record of casualties caused by historic tsunamis. The study on which this paper is based was initiated in recognition of the fact that standard sources of information disagree as to the number of fatalties caused in Hawaii by historic tsunamis, and in particular the number caused by the tsunami of April 1946 that killed the greatest number.

Attention was drawn to the disagreement as early as 1969 in a paper by Robert C. Schmitt, State Statistician, entitled "Catastrophic Mortality in Hawaii". The discrepancies have remained unexplained, two more tsunamis causing fatalities in Hawaii have since occurred, and some additional discrepancies in the record of Hawaiian tsunami casualties have come to light. The immediate impetus to the present study was reminders of the disagreement in the case of the 1946 tsunami that I recently received both from Schmitt and from Walter C. Dudley of the University of Hawaii at Hilo, and Schmitt's note that there is a discrepancy also in the case of the reports of the casualties caused by tsunami causing the second largest numbers of casualties in Hawaiii, that of May 1960.

In spite of the importance of the 1946 and 1960 tsunamis, minor discrepancies among the casualties attributed to them would be of little significance. In the case of the 1946 tsunami, however, the maximum reported number of fatalities exceeds the minimum by more than 20 percent. Hence it seemed important to determine which of the sets of casualty statistics reported for this tsunami, or what combination of the sets, was valid, or at least to determine approximately what the actual numbers of fatalities and other casualties were, and, in addition, to review, and correct as necessary, the entire historic record of tsunami casualties in Hawaii.

The methods used in the review of the casualty statistics for historic tsunamis in Hawaii, and the conclusions reached, are presented in this report. As will be seen, it proved impossible, in the case of most of the seven tsunamis known to have caused fatalities, to validate with certainty any of the the numbers that that have commonly been reported for the total fatalities. The best that could be done in most cases was to estimate ranges within which the actual numbers could be considered, with some certainty, to lie, and to pick in each case what seemed the most probable number. In the case of some of the tsunamis, no numbers of persons injured are available; and, in the case of most of the rest, the best that can be done is to settle on an approximate number.

Each of the next six chapters of this report deals with the casualties associated with one of the historic tsunamis that, according to Schmitt (1969), caused fatalities in Hawaii, those of November 1837, April 1868, May 1877, February 1923, April 1946, and May 1960. The seventh deals with one

occurring in November 1975, after the publication of Schmitt's paper. The last chapters deal with casualties associated or possibly associated with other historic tsunamis and with analyses of the historic record.

Sources of information

Standard sources

In the case of recent tsunamis, including that of 1946, the casualty statistics compiled by Schmitt (1969) were drawn from: i) official reports pertaining specifically to the individual events, such as that issued by the Red Cross (1946) for the 1946 tsunami; ii) official annual reports, such as that that issued by the Territorial Board of Health in 1946, that issued by the State Department of Health in 1960, and the earthquake summaries issued annually by the U. S. Coast and Geodetic Survey; and iii) previous compilations such as tsunami catalogs. For convenience, sources such as these, and others from which information has commonly been drawn for later studies, will be referred to in this report as "standard sources".

The compilations in most of the standard sources were completed months or years after the casualty-causing events to which they relate. In the case of some tsunamis occurring earlier in Hawaiian history, however, the standard sources were contemporary newspapers; and, as will be seen, contemporary newspapers are sources of information that may be used in checking the validity of statistics appearing in later-published standard sources.

Contemporary sources

Valid reports of the casualties caused by a tsunami that are prepared long after the occurrence of the tsunami must of course be based on records of the dead before their bodies are buried or cremated, of the missing while their disappearances can still be attributed reliably to the tsunami, and of the injured while there is still some expectation that they can be identified comprehensively, in other words on records that may be considered contemporary with the tsunami.

For several reasons death certificates constitute a particularly valuable kind of contemporary record. They may, for example, be counted at any time, even a time long after the deaths to which they relate occurred. As will be seen, particularly in the case of the 1946 tsunami, a count of the certificates recording the deaths due to a particular cause, although representing a minimum number of the deaths possibly due to that cause, may not represent the maximum number possible or even the most probable number. Hence complementary contemporary records are useful even if death certificates are available, and there was no system for filing death certificates at the times of occurrence of early in Hawaiian history.

Newspapers accounts represent the principal contemporary records of the numbers of the casualties due to several tsunamis; and, as will be seen, newspaper accounts have served as the major supplement to to information on casualties derived from death certificates in the case of other tsunamis. A systematic search for newspaper information on the tsunami casualties using, principally, microfilm copies of the newspapers filed at the University of Hawaii library. In the case of each tsunami known to have caused or suspected

of caused fatalities in Hawaii, the search covered issues of the principal newspapers published in Honolulu and on each island on which casualties were known or suspected within a period ranging from about a week to several weeks after the occurrence of the tsunami.

Some contemporary records of the casualties of an event may first appear in published form in books and journals published weeks, months, or even years after the event. A systematic search was made for information on tsunami casualties in the tsunami accounts in the publications of this kind that were cited in standard sources and in others that had been compiled in the course of an on-going study of the character of the historic tsunamis in Hawaii and of their effects generally. In the case of a few of the tsunamis, information was also drawn from sources such as diaries and letters, published or on file in museums or libraries, copies of which or notes on which had already been collected in the on-going study.

Other sources

Tsunami casualty reports were found in some publications other than standard and contemporary sources or notes on such publications that had been collected in the on-going study, and some came to attention incidentally in this study although such publications were subjected to systematic search only if they were cited in standard sources. Attention is drawn in this report to these other reports only if they included numbers of casualties differing from those reported in any source cited otherwise.

Categories of casualties and nature of casualty reports

Reports of the casualties resulting from a tsunami may include numbers of the identified dead (bodies found and identified), numbers of the unidentified dead, totals of the known dead (identified and unidentified), numbers of persons missing whose disappearances are attributable to the tsunami, totals of the presumed dead (sums of the identified dead and the missing), and numbers of persons injured. The nature of reported fatality statistics may be unspecified or described misleadingly, and in some cases what is reported as if a presumed-dead total may actually represent the sum of the total known dead and the missing although in such a sum any unidentified dead are counted twice.

It is expectable that the numbers of both dead and missing reported for a catastrophic event in successive issues of a daily newspaper should increase rapidly from issue to issue for the first couple of days or so. It is also expectable that the rate of increase in the numbers of those reported as known dead should slacken with time, and that the rate of increase in the number of persons reported as missing should slacken more rapidly and even turn into a decrease, not only because most of those missing are missed early but also because some bodies found later are likely to be identified as persons reported missing earlier. If the fatality categories were properly distinguished, if there were no mistakes in the numbers, and if the numbers were handled appropriately, it is expectable that both the numbers of individual persons listed and the totals published in later issues of the newspapers would converge with time toward the equivalents reported in standard sources published later.

TSUNAMI OF NOVEMBER 1837

Background and casualty reports in standard souces and in other recent sources

The earliest of the historic tsunamis known to have caused casualties in Hawaii was that of November 1837, which was generated off the coast of Chile. It arrived in Hawaii on the 7th of the month at about 7 pm. and caused considerable damage on Maui and Hawaii and losses of life on both islands.

In their monograph on the 1946 tsunami, Shepard, Macdonald, and Cox (1950) reported that the tsunami caused 14 deaths at Hilo, Hawaii, and two at Kahului, Maui. The total of 16 agrees with the total reported by Schmitt (1969). In addition to the deaths at Hilo and Kahului, 46 deaths in the Kau district of Hawaii were reported in the Pacific tsunami catalog (Iida, Cox, and Pararas-Carayannis, 1967) and the Hawaiian tsunami catalogs (Pararas-Carayannis, 1969); (Pararas-Carayannis and Calebaugh, 1977).

The total of 60 fatalities was reported in a brief review of tsunamis causing catastrophes in Hawaii in the Honolulu Star-Bulletin issue of 8 May 1986.

Contemporary and other early reports of fatalities and discussion

Both Shepard, Macdonald, and Cox (1950) and Schmitt (1969) cited Rooke (1838), and the numbers of fatalities that they reported agree with those reported by Rooke, a resident of Honolulu. Bennett (1869) relied on Rooke and reported the same numbers. However, Bingham (1848) and Jarves (1872), both residents of Honolulu at the time of the tsunami reported the numbers as 11 at Hilo and 2 at Kahului, and Alexander (1891) reported the number of fatalities at Hilo as 12.

The number of 11 for the fatalities at Hilo agrees with that recorded by two Hilo missionaries: David Lyman, in his manuscript diary on file at the Lyman House memorial museum in Hilo, and Titus Coan, in a letter published in part in the Missionary Herald (Coan, 1838). Sarah Lyman, David Lyman's wife, in her diary, filed at the same place as his diary, reported that 8 bodies had been found, but that several persons were missing. The number 11 was also reported by a student at the Hilo mission, Lucy G. Thurston, a letter written in Kailua-Kona in December 1837 that was published in a memorial to her (Cumings, 1842). However, a footnote to Coan's letter, apparently added by the editor of the journal, reads: "Another has since died."

Furthermore, according to Rooke, the number 11 included just the four men, two women and five children of two Hilo settlements, Kanokapa and Kaahelu, who lost their lives. The three additional deaths he reported were at other settlements at or in the vicinity of Hilo: a woman and child at Waiolama and Hauna, and another woman at Kaumale. Jarves also reported that the number of 11 deaths at Hilo referred to the lives lost "at two hamlets alone", although he did not report the additional losses elsewhere that had been reported by Rooke. Jaggar (1947) reported the same information that Rooke had, although without attribution to Rooke. The number of 14 was reported for the fatalities at Hilo in an informal compilation by the State Civil Defense Division (Schank, 1978).

On the basis of some information he had received from Hilo, Forbes (1984), a missionary at Kailua, Hawaii, reported in his journal on 12 November that the number of deaths at Hilo had been 11 or 12.

The number 12, at least as reported later by Alexander (1891), may represent the sum of the 11 fatalities reported in Coan's letter and the one additional fatality reported in the footnote to it. It also may have resulted from Alexander's substituted, for the number of fatalities, the number of persons who, out of the large number swept into Hilo Bay by the tsunami, were saved by boats put out by a whaler anchored there (Coan, 1838). A third possibility is that Alexander got the number from the report of Wilkes (1850), the commander of the U. S. Exploring Expedition that visited Hilo in 1840, which included both the number 12 for the fatalities at Hilo and the number 2 for those at Kahului. Wilkes identified Coan as the source of much of his information on the tsunami, although the number he reported for the deaths it caused, 12, does not agree with the number reported by Coan.

Still another number for the fatalities at Hilo, 13, was reported in an anonymous tract entitled "Four memorable years at Hilo" that was published about 1871 by the Repository of the Delaware Tract Association, Wilmington, Delaware.

The death of at least 11 persons at Hilo must be considered certain on the basis of the records of the two Hilo missionaries. Although Rooke was not at Hilo, the detail in which he reported the deaths of three more suggests considerable reliability to the report, and the total seems more probably 14 than 11. It is possible that the one additional delayed death reported in the footnote to Coan's (1838) letter was not included among the three additional reported by Rooke, and that the total was actually 15.

The reports of two fatalities at Kahului were undoubtedly based on information from Armstrong, a missionary at Wailuku, Maui. In a letter published in the Missionary Herald, Armstrong (1838) described one of the persons killed as an old woman whose son had attempted to save by swimming with her on his back but who was found dead when he got to shore; and the other as another old woman who, confused in the dark, got into a small "lake" and was drowned. Taken at face value, Armstrong's description of the death of the second woman would suggest that it could properly be attributed only indirectly to the tsunami. However, he also reported that the waves of the tsunami swept the wreckage of houses, broken canoes, animals, and men, women and children into the "lake" (probably a large, brackish coastal pond), and he could only have surmised that she was she was not one of the women whose translocation to the pond was the direct result of the tsunami. Hence no significant distinction between the ways in which the tsunami caused the deaths of the the two women seems justified.

Brigham (1868), also, reported the two dead at Kahului, as, subsequently, did Jaggar (1931 and 1946) and Schank (1978). Jaggar, in the second paper cited, paraphrased much of Armstrong's account.

The there is no contemporary information confirming the report in the Hawaiian tsunami catalogs (Pararas-Carayannis, 1969, and Pararas-Carayannis and Calebaugh, 1977. Also in Shank's 1978 compilation) that 46 persons were killed (and 108 houses destroyed) by the tsunami in the Kau district of

Hawaii. That report seems clearly to represent erroneous attribution to the tsunami of November 1937 of effects of the tsunami of April 1868 (see next chapter).

Conclusions

It may be concluded that the number of deaths at Hilo caused by the 1837 tsunami may have been as small as 11 or as great as 15 but was most probably 14; that the number at Kahului was two; and hence that the minimum, probable, and maximum totals for the islands a whole were, respectively, 13, 16, and 17.

TSUNAMI OF APRIL 1868

Background and numbers of casualties reported in standard sources and other recent sources

The tsunami of 2 April 1868 accompanied a major earthquake whose epicenter was on the southeast coast of the island of hawaii. The earthquake, which was felt on all of the major islands, had disastrous effects on Hawaii. The tsunami had very high runup heights on the southeast coast of Hawaii in the Kau and Puna districts, where it caused considerable damage. It caused some damage on other coasts of the island of Hawaii, and it was observed as far away as Honolulu.

The only area for which there have been reports of casualties attributable to the tsunami, as distinct from those attribitable to a large landslide triggered by the earthquake, was the south Puna-Kau coast of Hawaii; and only reports available pertain to the fatalities there.
However, three different numbers of fatalities have been reported in standard sources:

81 in the Pacific tsunami catalog (Iida, Cox, and Pararas-Carayannis, 1967);
in the Hawaiian tsunami catalogs (Pararas-Carayannis, 1969; and Pararas-Carayannis and Calebaugh, 1977); and
in a monograph on the 1946 tsunami (Shepard, Macdonald, and Cox, 1950), where the number was given as "at least 81".

67 as an alternative number in the first of the Hawaiian tsunami catalogs (Pararas-Carayannis, 1969).

46 in Schmitt's (1969) paper on "Catastrophic Mortality in Hawaii" (in which fatalities attributed to the combination of the tsunami and the landslide was reported to be 81).

According to Cox and Morgan (1977):

> Of the total deaths resulting from the catastrophic event (variously estimated at 77 (Brigham, 1869), 92 (Coan, 1869), or 81 (Bennett, 1869; Schmitt, 1969)) 46 resulted from the tsunami, all in Kau (Brigham, 1869; Coan, 1869; Schmitt, 1969).

Rather than the Brigham and Coan reports cited above, Schmitt (1969) cited issues of the Hawaiian Gazette published on 15 April and 29 April 1868, an article in the missionary journal, The Friend (Anon., 1868), and a paper by Hitchcock (1912). All of these sources of information and those cited by Cox and Morgan do indeed attribute 46 deaths, or approximately that number, to the tsunami, as did Hitchcock (1909) in a book published three years before his paper on the earthquake and associated phenomena.

In a recent review of the catastrophic tsunamis of Hawaii published in the Honolulu Star-Bulletin issue of 8 May 1986, the number of fatalties due to the tsunami was said to have been 148.

Contemporary reports of numbers of fatalities

The number of 67 for the fatalities of the tsunami is attributed in the Hawaiian tsunami catalog to Coan (1868 a), a letter from Coan to J. D. Dana, editor of the American Journal of Science published in that journal. In the body of the letter, which was dated 7 April, Coan relayed a description of the tsunami as a tidal wave caused by "a submarine disgorgement of lavas into the sea" and stated: I have seen forty-seven names of the killed in the earthy eruption, some six miles from the sea [the landslide] and this influx of the ocean. These statistics include only the eastern portion, or less than one-fourth part of Kau." The number 67 was reported in what appears to have been a postscript, dated 10 April, which read, part: "67 lives lost by the influx of the sea, and no shore village standing." In another letter that was published in the same issue of the American Journal of Science as Coan's, one dated 10 April, Lyman (1868) who was apparently in Kau at the time of the event, wrote: "The eruption of earth destroyed thirty-one lives, but the waves swallowed a greater number". Lyman's letter indicates only that the number of fatalities attributable to the tsunami was greater than 31. In a letter published in the Missionary Herald that was written, or at least begun, on 9 April, Coan (1868 b) repeated essentially the early information as that quoted from his 7 April letter and added: "Since writing the above, I have seen two notes from Kau , stating that . . . sixty-seven persons had been killed . .."

Coan's later report giving the number of fatalities as 46 (Coan, 1869) was in the form of another letter to Dana , one dated 1 September 1868 after he had personally made a tour of the Kau district. In it he indicated that the tsunami had not resulted from a submarine eruption. The number of fatalities was in a table of the numbers of houses destroyed by the earthquake itself, by associated volcanic eruptions, by the landslide, and by the the "influx of the sea", and the numbers of deaths caused by the last two phenomena. The number of deaths he attributed to the landslide was the same as that reported by Lyman, 31, making the total of deaths from both causes 77. (The total of 92 attributed by Cox and Morgan (1977) to Coan was probably derived mistakenly by adding the number Coan reported for the lives lost to the tsunami to the number next to it in the table, but that number related to the houses destroyed by the tsunami rather than the lives lost to the landslide.) Coan repeated his report of 46 fatalities due to the tsunami in his autobiography (Coan, 1882). Both there and in his earlier reports, he stated that all of the loss of life was in the Kau district and that no lives were lost in the Puna district. More recently, Jaggar (1931) and Powers (1946) reported 46 as the total number of tsunami fatalities.

Brigham (1869, 1909) quoted Coan's (1869) table of damages and fatalities, identifying them as losses in Kau, but added: "One life was lost in Puna by the sea-wave, and one in Hilo by a falling cliff." The death in Puna was probably one reported in the Gazette of 15 April on the basis of a communication from the schooner "Oddfellow" which made a trip southeastward along the southern coast of Puna and the coast of Kau a few days after the occurrence of the earthquake and tsunami. An entry at the end of a report on the destruction of a number of villages in Puna read: "An old native woman was drowned at Apua in endeavoring to save her dwelling. No one was hurt at Keauhou."

In his earlier paper, Brigham (1869), also quoted a report from a passenger on the "Oddfellow" which included, in an entry dated 7 April after the Oddfellow had continued southwestward from Kaalualu: "At Halii found the body of a native woman lying among the rocks...mutilated by sharks." The finding of this body was also reported in the communication from the "Oddfellow" that was quoted in the Gazette of 15 April, but the communication also reported "Farther on, at Hanalua, was aanother dead woman, partly buried in a pile of drift....". Because Coan's and Fornander's casualty information may have been restricted to the part of the Kau coast northeast of Kaalualu, which served as the port for the mission station at Waiohinu, the numbers of casuaties they reported may not have included thke deaths at Halii and Hanalua.

Yet another contemporary report on the tsunami fatalities implied that they numbered 48 or 49. This was the report in The Friend (Anon, 1868), clearly based on early information, that: "About fifty natives were unfortunately swept off to sea, and only one or two survived."

The source of the report that the number of fatalities was 81 appears to be a paragraph concerning losses due to the complex of events associated with the 2 April earthquake that appeared in a letter that was quoted at length in the Hawaiian Gazette of 29 April, which identified the writer as the School Inspector, and in the Pacific Commercial Advertiser of 9 May, and parts of which were quoted by Bennett (1869), who, as the Advertiser had, identified the writer as [Abraham] Fornander:

> The number of people now known to have perished between Ninole and Keaiwa, (Punaluu and Hionamoa included) is 47; at Kawaa [Kawa ?] 7; at Honuapo, 27; total 81, besides a number of the pulu pickers up in the mountains back of Hilea, how many I am not yet advised, neither have I heard the number of those who perished at Kaalaala".

Although Fornander made no distinction between the fatalities due to the tsunami and those due to the earthquake and other phenomena associated with it, some information on the distribution of the tsunami fatalities may be deduced from the locations of the places he mentioned. Keaiwa, Hionamoa, and Kaalaala are names now attached to inland gulches (Armstrong, 1973) in an area southwest of the site of the large landslide, but the deaths associated by Fornander with those names may represent or include those due to the landslide. Ninole is on the coast, but Fornander reported no number for the fatalities there specifically. Deaths at Kawa and at Honuapo, both coastal villages, must have resulted from the tsunami, and, although the sum of Fornander's numbers for the fatalties at those places does not correspond to Coan's total for Kau, there is nothing to suggest that Fornander's numbers for the deaths at those places should not be considered probably correct.

Earlier, the Advertiser (18 April) had published a estimate by its editor, H. M. Whitney that the death toll might eventually be found to be between 80 and 100, and this range was later reported by Westervelt (1916). Although neither Whitney nor Westervelt distinguished between deaths due to the tsunami and those due to other phenomena of the complex event, Whitney's estimate may have been the basis for reports by Dutton (1883) and by Alexander

(1891) that, as the result of the tsunami: "Over eighty perons perished in a few minutes...".

The number of 108 reported for the tsunami fatalities in a State Civil Defense Division compiliation (Schank, 1978) and in a review in the 8 May 1986 issue of the Honolulu Star-Bulletin probably represents the sum of the 67 reported initially by Coan and the 81 reported by Fornander, although Coan's number, if correct, would have been included, together with non-tsunami fatalities, in Fornander's 81.

Numbers of fatalities resulting from the tsunami (or totals that might have included tsunami fatalities) for specific places in Kau were reported earliest in the Advertiser of 11 April. The reports were contained in a letter written 3 April in Waiohinu by J. F. Pogue, the missionary at that place; a 6 April postscript to Pogue's letter; a letter written 8 April in Kealakekua, Kona, by H. M. Whitney, the Advertiser's editor; and an undated postscript to Whitney's letter. The numbers were as follows:

		Pogue		Whitney	
Place	Cause	Original	Postscript	Original	Postscript
Punaluu	Tsunami			3	
	Total				4
Honuapo	Tsunami	16			
	Total			16	27
Paliuku	Tsunami				13
	Total		37		33
Makaha	Total				13
Kamilo	Total				8

Pogue reported the 16 tsunami fatalities only has having occurred at one village. They are attributed to Honuapo in the above table on the basis of Whitney's original report of 16 fatalities there. Paliuku, Makaha, and Kamilo, are place names not in present use. Whitney described Paliuku as "beyond Waiohinu", probably meaning to the east of Waiohinu. (Pogue spelled the name of the place Paliuka). Although the total fatalities at Honuapo reported in Whitney's postscript agrees with the total reported by Fornander, many of the numbers Whitney reported seem unreliable. In addition to the numbers given above, he reported that about 20 deaths had occurred at Waiohinu, whereas Pogue who lived there reported none. The identity between the number of tsunami fatalities Whitney reported at Paliuku and the total fatalities he reported at Makaha is suspicious, as is the identity between the number of total fatalities he reported at Paliuku and the number of fatalities that he attributed to the large landslide triggered by the earthquake at Kwaiwa on Kapapala Ranch. (What was probably the actual number of landslide fatalities, 31, was reported later by Fornander (Gazette, 29 April), and by Lyman (1868), Coan (1869), and Brigham (1869).

Conclusions

In the second of his letters published in the American Journal of Science, the one written after his tour of Kau, Coan (1869) indicated that some of the information that he had received before the tour and reported in the first of the letters (Coan, 1868 a) was wrong. Although he did not specifically identify as incorrect the number of 67 that he had reported in the first of the letters (and in Coan, 1886 b) for the deaths in Kau, it may be assumed that the 46 that he reported in the second letter (and in Coan, 1882) was a correction of and replacement for the number earlier reported. It may also be assumed that Coan's number included the seven deaths at Kawa and the 27 at Honuapo that were reported by Fornander. The number 46 may therfore be accepted as both the minimum possible number and that most probable for the tsunami fatalities in the Kau district. It is, however, uncertain whether Coan knew of the two deaths on the coast southeast of Kaalualu that were reported in communications from the schooner "Oddfellow". Hence the number of fatalities in Kau may have been as large as 48, or even larger because there might easily have been deaths in addition to those of the two persons whose bodies were found by the people from the "Oddfellow"

Considering that the report in Brigham (1869) of one death in Puna and the report from the "Oddfellow" of the death of a woman at Apua referred to the same person, the number 47 has been accepted as the minimum and most probable for the tsunami fatalities overall, and at least the number 49 for a possible maximum equivalent.

Accepting as certain the number of 31 deaths resulting from the landslide at Keaiwa and as probable the death in the Hilo district resulting from rock fall (Brigham, 1869), the total number of fatalities resulting from the combination of phenomena associated with the earthquake may be considered at least 77, most probably 79, and possibly 81 or more.

TSUNAMI OF MAY 1877

Background and casualty reports in standard sources

The tsunami of May 1877, which was generated, like that of November 1837, off the coast of Chile, arrived in Hawaii on the 10th of the month at about 5 am. causing extensive damage in Hilo.

According to standard sources (Shepard, Macdonald, and Cox, 1950; Iida, Cox, and Pararas-Carayannis, 1967; Pararas-Carayannis, 1969; Schmitt, 1969; Pararas-Carayannis and Calebaugh, 1977) the tsunami caused five deaths in Hilo. According to Shepard, Macdonald and Cox, it resulted in injuries to 7 there, but according to Pararas-Carayannis and Pararas-Carayannis and Calebaugh the number was 17.

Sources of information cited by the standard sources that reported statistics on casualties of the tsunami included: the Hawaiian Gazette issue of 23 May 1877; Coan, (1882); Gordon-Cumming (1883); Alexander (1891); Hitchcock (1909, 1911); Westervelt (1916); Jaggar (1931, 1947); and Powers, (1946).

Contemporary reports of casualties

The 23 May issue of the Gazette was the second containing news on the character and effects of the tsunami on Oahu, on Maui, and on the northwestern part of Hawaii, but the first containing news from Hilo. The principal article on the tsunami at Hilo was based primarily on three letters, which it quoted in full. All three described the losses as greatest at Waiakea. The first, addressed by J. J. Porter to the editor and dated 14 May, reported five dead and many maimed and disfigured. The second, addressed by L[uther] Severance [the Sheriff in Hilo] to W. C. Parke, [Marshall of the kingdom of Hawaii] and dated 11 May, included a tabulation of the losses in which the numbers of dead and injured were reported as five and seven, respectively. The third letter, addressed by T[itus] Coan to the editor and dated 12 May, reported: "Five lives were lost, and eighteen persons were more or less wounded, some with broken bones, others with bruises on the head, face, and other parts of the body, and scores escaped..." Coan's letter indicates that two of the deaths were in the western part of what is now the town of Hilo rather than at Waiakea, and that the body of of one was carried out to sea and recovered off Honolii (about two miles north of Hilo). A second article in the same issue, identified as "from a letter by a lady" that was dated 11 May at Hilo, described the circumstances under which four bodies were found, those of a man, a woman, and two children, and described the serious injuries of five persons, four men and a child.

The unnamed lady who wrote the letter quoted in the Gazette may perhaps have been Lucy Coan, Titus Coan's wife, because Coan's autobiography (Coan, 1882) contains an extract from a letter written by her that describes some details of the effects of the tsunami that were described in much the same way but not in the same words, by the unnamed lady. Lucy Coan's letter reported: "Five lives have been lost; twenty persons are more or less injured".

Hitchcock (1909, 1911) quoted the same Severance letter that had been quoted in the Gazette of 23 May. The death toll of 5 was reported also by

Gordon-Cumming (1883); Alexander (1891); Westervelt (1916); Jaggar (1931, 1946); and Powers (1946), some of whom also reported the 7 persons injured.

Conclusions

There can be no doubt that the number of fatalities caused by the 1877 tsunami at Hilo was five. Titus Coan's letter indicates that two persons lost their lives in the western part of the town. The other three probably lost their lives in Waiakea.

There can also be no doubt that the number of persons seriously injured was at least seven, the number reported by Severance. The number may well have been greater, but the numbers reported by Titus and Lucy Coan, 18 and 20 respectively, seem clearly to have included some whose injuries were not severe.

TSUNAMI OF FEBRUARY 1923

The tsunami of February 1923, generated off the coast of Kamchatka, arrived in Hawaii on the 4th of the month shortly at about noon. It caused considerable damage at Hilo, Hawaii, and at Kahului, Maui. Standard sources (Shepard, Macdonald, and Cox, 1950; Iida, Cox, and Pararas-Carayannis, 1967; Pararas-Carayannis, 1969; Schmitt, 1969; Pararas-Carayannis and Calebaugh, 1977) are agreed that the tsunami caused one death in Hilo, that of a fisherman according to Schmitt (1969).

Sources of information that were cited in the standard sources and that contained information on casualties of the tsunami included: Jaggar (1923, 1926, 1931) the Honolulu Advertiser issue of 4 February, Powers (1946 a), and Thrum's Annual (Anon. 1923).

According to three extra editions of the Honolulu Star-Bulletin issued early in the afternoon of 3 February, the first reporting on the tsunami, the deaths of four fishermen at Hilo had been reported. The Advertiser of 4 February put the total at 10 or perhaps 12. The Hilo Tribune-Herald of 4 February also reported that the total might be as great as 12 but that only one death had been confirmed, that of a fisherman, J. Hamasaki. The Advertiser of 5 Febrary also reported that but one death at Hilo had been confirmed. Articles in the Advertiser and the Tribune-Herald indicated that those earlier thought dead included the six-man crew missing from a sampan seen running up the Wailoa river without a helmsman, the crew of a sampan swept into Hilo Bay, a child swept off another sampan, and a man beheaded when the sampan on which he was riding was driven under a railroad bridge across the mouth of the Wailoa River. The Star-Bulletin of 5 February reported that but one body had been recovered and identified the victim both as Hamasaki and as the man beheaded at the railroad bridge, and reported that he was a sampan owner who had been attempting to save his sampan. No issue of either of the Honolulu newspapers, the Hilo Tribune-Herald, or the Maui News, which described the tsunami and its effects at Kahului, reported any known dead or definitely missing other than the one fatality at Hilo.

Although the extent of the damage at Kahului and Hilo was so great that it seems almost certain that there were persons injured at both places and probable that there were some injured seriously, there were no reports of injuries at either place in any of the newspapers.

In conclusion, the 1923 tsunami caused one death, that of the fisherman at Hilo, but there is no information available on the number of persons it injured.

TSUNAMI OF APRIL 1946

Background and casualty reports in standard sources

The 1946 tsunami, which originated off the eastern Aleutian islands, arrived in Hawaii on the first of April at about 6:30 Hawaiian Standard time. It caused extensive damage on all of the major Hawaiian islands, and losses of life on Hawaii, Maui, Oahu, and Kauai.

Essentially four incompatible sets of casualty statistics for the tsunami have been published in standard sources. In some of the sources, but not all, the totals were broken down by place and distinctions were made between the categories of fatalities. The statistics and the sources in which they appear are shown in table 1.

Contemporary records and other information

Red Cross, Board of Health, and Cancer Research Center records

Although a search was made for contemporary Red Cross records from which might have been compiled the tsunami casualty statistics appearing in the Red Cross report and other standard sources of set 1, none were found.

No specific record of the means by which the casualty statistics published by the Territorial Board of Health seems now to be available in the files of its sucessor, the State Department of Health. However, thanks to George Tokuyama, the Departeent's Registrar of Vital Statistics, access was provided to the death certificates filed with the Board and to an alphabetized card file serving as an index to a variety of certificates filed with the Board during the period including 1946. For brevity, the initals BOH will be used below in referring to the Board of Health.

The death certificate file for the filing-date period from the beginning of April until the middle of May 1946 was initially searched for certificates in which the deaths were attributed to the tsunami. Entries in the card file, found as explained below, led to the discovery of a few certificates not found in the initial search, including some filed after the middle of May. The dates of death reported in most of these certificates were the date of occurrence of the tsunami; and the deaths were most often attributed to drowning. However, a few deaths occurring several days later were attributed on the certificates to injuries or exposure caused by the tsunami. Most of the pertinent certificates pertained to bodies found and identified, a few pertained to unidentified bodies, and several pertained to persons missing and presumed dead.

Use was made of the BOH card file after a list of fatalities attributed to the tsunami in the newspapers had been compiled. The file was searched for records of persons who were included in this list but for whom death certificates had not initially been found. Cards in the file were found to pertain, not only to persons for whom death certificates had been filed, but also some missing persons, presumed dead as the result of the tsunami, for whom death certificates had not been filed. The cards indicated that

Table 1. Numbers of casualties reported in standard sources, 1946 tsunami.

Source set		Hawaii Hilo	Hawaii Island	Maui Keanae	Maui Island	Oahu Kahana	Oahu Island	Kauai Island	Total	Notes
1	Known dead								115	i
	Missing	0							44	i
	Total	96	121	3	14	3	9	15	159	i
	Injured		153	2	2		0	8	163	ii
2	Dead								142	iii
3	Dead		124		14		6	17	161	iv
4	Dead	58,68,173					5		173	v
	Injured	163	100							vi

Sources

Set

1 Red Cross, 1946.
Shepard, Macdonald, and Cox, 1950.

2 Hawaii Board of Health, 1946.

3 Thrum's Hawaiian Annual (Anon, 1946 a).

4 Eastern Sect., Seismological Soc. Amer. (Anon, 1946 b).
U. S. Coast and Geodetic Survey (Bodle and Murphy, 1948); Salsman, 1959.
Pacific tsunami catalog (Iida, Cox, and Pararas-Carayannis, 1967).
Hawaiian tsunami catalogs (Pararas-Carayannis, 1969; Pararas-Carayannis and Calebaugh, 1977).

Notes

i The numbers of known dead and missing and the numbers of fatalities at Hilo, Keanae, and Kahana were reported only by Shepard, Macdonald, and Cox (1950), who reported also that there were "several" fatalities at Laupahoehoe, Hawaii; at Hana, Maui; and at Haena, Kauai; and that there were "some" at Wainiha and Kalihiwai, Kauai.

ii Injured sufficiently to require hospitalization.

iii Including three children.

iv Date of tsunami given as 1 April 1947.

v

Reported numbers of dead:	Hilo, Hawaii	Kaena Point, Oahu	Total
Eastern Sec., Seismol. Soc.	58	5	173
Hawaiian tsunami catalogs	173		
Pacific tsunami catalog	68		173

vi Reported numbers of injured: Eastern Sec., Seismol. Soc. 100 on Hawaii
Hawaiian tsunami catalogs 163 at Hilo

information on the missing persons had been drawn from some list of missing persons but did not identify the list.

For a final check, use was made of a computerized file of vital statistics compiled by the Cancer Research Center of the University of Hawaii from records of the Board of Health and its successor, the State Department of Health. Access to this file was provided by courtesy of M. P. Mi of the Center.

Newspaper accounts

A major source of information on the casualties of the tsunami was accounts in the newspapers of the time. The newspapers in which information was sought were the two major papers published in Honolulu, the Honolulu Advertiser and the Honolulu Star-Bulletin, and the three neighbor-island newspapers: Hilo Tribune-Herald (Hawaii), Maui News (Maui), and Garden Island (Kauai). Use was made of the microfilm copies of these newspapers at Hamilton Library, Univerity of Hawaii.

The first accounts of the tsunami appeared in several editions of the Star-Bulletin published on the day of its arrival. Additional accounts were published in almost every edition of each of the newspapers for about the next week, and occasionally thereafter until mid-April 1946. Although there were discussions in some accounts of the fates of some individuals, most of the casualty information in them was in one of two forms: summary statistics and lists of victims. The statistics were reported most often in tables of numbers of the dead, missing, or injured pertaining to a specific place, to an island, or to the islands as a whole. Some of the lists were of persons known to be dead, some to persons missing. Some of them contained only the names of victims, some gave their ages, and some indicated their places of residence in addition. Some were in the form of updates of previous information rather than complete lists. Most of the lists pertained to islands but some pertained to specific places--most often Hilo and Laupahoehoe on Hawaii where the numbers of casualties were largest.

Summary statistics for the islands as whole were published by the Star-Bulletin on 2 May 1946, just over a month after the occurrence of the tsunami, and on the anniversaries of its occurrence in 1947 and 1949.

Most of the summary statistics and lists, including the statistics published in May 1946 and on the anniversaries of the tsunami, were attributed in the newspapers to the Red Cross, which evidently served as the institution principally responsible for collecting and collating such information.

Other contemporary reports

In a report apparently published less than a month after the occurrence of the tsunami, Powers (1946) stated "Over 200 persons are known to have lost their lives or to be missing", and, in a brief, non-technical account, Jaggar (1947) reported that the numbers of the dead and missing were, respectively, 115 and 67. Neither the 200 reported by Powers nor total of 182 derived from Jaggar agree with the number reported in any standard source. However, Jaggar identified his numbers as rough estimates compiled only a week after the tsunami, and the number reported by Powers was probably derived about the same

time. Neither number agrees with that reported in any particular newspaper at that time, but both are within the ranges reported by the newspapers generally. Hence the reports by Powers and Jaggar were given no independent consideration in this study.

Initial statistical analysis

The analysis of the information in the BOH files and the newspapers began with the collation, by casualty category and by place, of numbers of casualties reported in the newspapers and indicated by counts of the newspaper lists, the death certificates filed for tsunami victims, and entries for additional victims in the BOR card file. The corresponding numbers thus collated were then compared with each other and with corresponding numbers reported in the standard sources.

For the islands as a whole, the results are summarized in table 2. The statistics of the first group on the table are those reported in the standard sources, those of the second group were derived from the BOH files, and those of the third group were derived from the newspaper accounts.

In the case of the statistics based on the death certificates, the totals of the presumed dead were calculated by adding the numbers of the missing to the total numbers for the known dead rather than the numbers of the identified dead because the unidentified bodies for which death certificates were filed were found where they could not have been those of any of the missing for which there were death certificates. In the case of the statistics based on the combination of the certificates and the DOH cards, there is an unavoidable uncertainty of three in the total presumed dead.

It will be noted that the number of dead reported in the set-2 standard source (BOH), 142, is two greater than the number of death certificates filed for direct victims of the tsunami, including those missing, but at least three smaller than the number of direct victims suggested by the combination of death certificates and BOH card-file entries. The contribution of the tsunami to the death of the one indirect victim to whom reference is made in the table will be discussed later. It is sufficient for the present to note that inclusion of that victim would not lead to agreement between the set-2 number and any of those suggested by the BOH files.

The number of known dead reported in Shepard, Macdonald, and Cox (1950) (one of the standard sources of set 1), is identical to the number of identified dead for whom death certificates were issued, but does not include 3 unidentified bodies for whom death certificates also were issued; and the number of missing reported in Shepard, Macdonald, and Cox is significantly larger than the number of missing suggested by the BOH files.

The presumed-dead totals reported in the standard sources of sets 1, 3, and 4. are all significantly larger than the totals suggested by the BOH files.

The 5th of April is selected as the beginning of the part of the month for which the numbers derived from the newspapers are summarized in the table because, by that date some convergence of the numbers reported in successive issues should have been expected. As indicated by the tabulated ranges,

however, there was little convergence. All of the numbers reported in the standard sources for specific casualty categories fall within the corresponding ranges derived from the newspaper accounts, but the ranges provide no evidence of the relative reliability of the standard-source numbers.

Table 2. Numbers of casualties in the islands as a whole due to the 1946 tsunami as reported in various sources and derived by analysis.

	Dead, unspecified	Dead, identified	Dead, unidentified	Dead, total known	Missing	Dead, presumed total	Injured
Standard sources							
Set 1				115	44	159	163
Set 2	142						
Set 3						161	
Set 4						173	
Board of Health records							
Death certificates *		115	3	118	23	140	
Additional cards					8		
Combination *		115	3	118	30	148	
Newspaper reports							
5 to 15 April 1946	102-119	95-124	4-6	99-124	50-74	153-190	
200-4568							
2 May 1946	123				50	173	291
1 Apr 1947 & 1949	159						
Analysis of newspaper lists							
Reliability rating:							
a *		107			37	144	
b or higher *		113			54	167	
c or higher *		120			63	183	
d or higher *		127			83	210	
Combined evidence							
Minimum *		115	3	118	24	141	
Probable *		121	4	125	38	159	
Maximum *		124	5	129	51	173	
Final conclusions							
Minimum *		115	3	118	22	141	
Probable *		121	4	125	38	159	168
Maximum *		124	5	129	53	173	

* Numbers do not include one death at Hilo certainly but indirectly attributable to the tsunami.

Numbers of persons injured reported in newspapers of 3 April.

The presumed dead total reported in the Star-Bulletin issue of 2 May 1946, 173, is identical to the total reported in the standard sources of set 4, and that newspaper seems very likely to be the source of the latter report. However, that number, attributed in the newspaper to the Red Cross, is considerably larger than the 159 that was reported in the anniversary editions of the newspaper with attribution to the Red Cross and reported also in the standard sources of set 1, including the Red Cross itself.

Analysis of lists of fatalities

Methods

To investigate the nature of the disagreements as to the numbers of dead and presumed dead, the lists of dead and missing published in the newspapers and compiled from the death certificates and BOH cards were compared with each other, not only as to the numbers of individuals they included, but as to the names of the individuals. In the case of the names in the newspaper lists, the comparison was made difficult by the fact that, although the names were listed in nearly alphabetic order in some issues, they were listed in almost random order in others, and by the fact that they were listed for the entire island of Hawaii in some issues but for Hilo and Laupahoehoe separately in others.

In many cases, furthermore, differences were found, list to list, in the spelling of the name, the age, or the place of reference for what seemed to be the same person. In several cases the differences were even greater. For example, each of the following pairs of names found in different lists probably refers to a single person at Hilo: Antone Correa and Antone Correa Aguiar; Augustine Martines and Martines Augustine; and Miss Hirabara and Mrs. Hirabara. Information in BOH files indicates that the persons referred to in newspaper lists for Hilo as Jack Sakae Sekimura, Masuyo Sekimura, and Rupert Sekimura were also known as Jack Sakae Furuya, Myrna Masuyo Furuya, and Rupert Asato Furuya. The family name of three children reported dead at "Kalama Bay" in the first published list for Oahu was given as Haaheo. In a later list the family name was still reported as Haahkeo but the place of death was reported as Kahana. The place was reported as Kahana Bay in still later newspaper lists and in death certificates, but in these the family name was reported as Kahananui, and Haaheo is given simply as one of the middle names of one of the children. To add to the confusion, one newspaper published a picture of the surviving Kanakanui grandmother of the children giving the place as Hauula.

In the case of each of the above pairs of names, only one name was included in any one newspaper list, and a reasonably consistent record was produced by the combination of the records associated with the individual names. Hence in cases of this kind, some of which included three or four somewhat different names instead of only two, it was assumed in the analysis of the lists that only one person was represented by each pair or group of names. In some cases, however, both names of a pair that seemed probably to relate to a single person, were included in the list or lists published in a single newspaper issue. In these latter cases it considered, at least initially, that each name might pertain to a separate person.

The lists published in the newspapers and compiled from the BOH files contained a total of over 360 names and variants. With initial elimination of

the variants, the number was reduced to 233. To facilitate the comparison of the lists, these remaining names were arrayed in a matrix against the sources of the lists (death certificates, BOH cards, or newspaper issues) in which they were included. Different symbols were used to indicate the inclusion of a particular name in the list or lists of a particular source to differentiate inclusions in lists of the dead from inclusions of the missing and to differentiate between inclusions in comprehensive lists and those in lists that simply constituted amendments of earlier lists. In the case of 14 of the names, there were entries in lists of subtractions indicating that the persons to whom they applied, although earlier thought to be dead or missing, had later been located alive and well. Even with the elimination of these 14, there were considerable gaps in the matrix that could be accounted for only by inconsistencies and unreliability in reporting. Hence the relative reliability of the reports of death or disappearance of each of the remaining 219 individuals was estimated, first on the basis of the newspaper evidence, and second on the basis of the combination of newspaper and BOH evidence.

The relative reliability of the newspaper evidence as to the inclusion of a person among the victims of the tsunami was indicated by a four-letter rating scheme. In general, the highest rating (a) was assumed to attach casualties documented by the combination of: 1) inclusion in a comprehensive list in at least one of the Star-Bulletin issues of 5 and 6 April (the last two issues containing such lists); inclusion in a comprehesive list in the Advertiser issue of 9 April (the only one published after 5 April that contained such a list); 3) if a neighbor-island victim, inclusion in a comprehensive list in at least one issue of the respective neighbor-island paper or, if an Oahu victim, inclusion in a list in at least one additional issue of a Honolulu newspaper; and 4) lack of inclusion in a list indicating that the person was no longer thought to be a victim. The second highest rating (b) was, in general, assigned to casualties whose documentation failed to meet only one of the first three criteria for rating (a). Rating (c) was, in general, assigned to casualties documented less well but better than by inclusion in only a single newspaper list. Rating (d) was, in general, assigned to casualties thought probably to be duplications of casualties with higher ratings and others documented by inclusion in but one newspaper list. A person reported as missing in early lists but dead in later ones was considered to have died although the rating attached to the death might have been been based in part on inclusions in lists of the missing.

A list of the persons whose deaths or disappearances had been rated (d) or higher but for whom no death certificates had been found was the basis for the search of the BOH card file that turned up both a few more death certificates and the cards for missing persons without death certificates.

In reaching final conclusions on the basis of the combination of newspaper and DOH information, a death or disappearance was regarded as certain if it was reported in a death certificate, in general probable if it was indicated by an entry in the BOH card file, by an (a) rating in the newspaper list analysis, or both; and, in general possible if it was indicated only by a (b) rating in the newspaper list analysis. As will be shown later, the overall total of the certain, probable, and possible presumed deaths was greater than the largest total reported in a standard source. Hence casualties rated only (c) or (d) in the newspaper list analysis were disregarded at this stage.

In a number of special cases discussed in the next section, the criteria used generally for the assignment of reliability ratings in the analysis of the newspaper lists or for identifying the probable and possible casualties in reaching the conclusions were considered inapplicable.

For a final check on the status of persons whose deaths or disappearances were initially rated probable or possible, in other words those for whom no death certificates had been found, a search was made for entries of their names in the computer file of the Cancer Research Center. This search resulted in the recognition, as discussed in the "Special cases" section, of one more pair of names belonging to one person than had earlier been recognized, and hence in the reduction by one of the number of those whose deaths had been considered possible.

The persons whose deaths or disappearances were finally concluded to be certain, probable, and possible are listed in the appendix to this report. The names and ages given in there for persons for whom death certificates were filed are those shown on the death certificate. Strictly alphabetic order was violated in the list where neccessary to keep together persons who were probably members of the same family whose name as shown in death certificates differed from that given in the newspapers.

Special cases

Evidence was found in newspaper accounts, in BOH records, or in the Cancer Research Center file, that the criteria that seemed appropriate generally in the assignment of reliability ratings or in reaching final conclusions as to which fatalities or presumed fatalities were probable or possible were inappropriate in a number of special cases. These cases, and others in which there were peculiar aspects of the deaths or disappearances due to the tsunami are discussed below.

The names Kama Kokazu, Kana Kokazu, Kama Kamakazue, and/or Kana Kakazue, identified in many cases as Mrs., appeared in the newspaper lists of those dead at Hilo or on the island of Hawaii. The residence associated with these names, if given, was Kohala or Anaehoomalu (in South Kohala). The age, if given, was consistently 67. Both Kama Kokazu (Kohala) and Mrs. Kana Kakazue (without residence) were included in the list in the Advertiser of 5 April. According to a brief article concerning losses on the Kona coast of Hawaii appearing on a different page in the same issue: "At the Parker ranch beach home at Anaehoomalu, Mrs. Kakazu, wife of the carekeeper of the property was drowned when she was washed into a fishpond by the last big wave which struck the coast". Although no other report seems to mention any loss of life on the Kona coast, the fatality at Anaehoomalu is confirmed by a death certificate in which the woman's name is given as Uto Kakazu. The possible death at Hilo of a person with a similar name was assigned reliability rating (d) in the newspaper-list analysis, but discounted in the final conclusions.

Each of three names, C. L. Duhas, Rufino Lausa, and Kwock Wah Lee, that were included in only one list, that of the dead at Hilo in the 2 April issue of the Tribune-Herald, was followed in the list by the note: "...body enroute to Kahului, Maui, aboard the S. S. Bingham". The deaths of these three persons seemed initally to merit a (c) rating on the grounds that concerns with them on the part of the authorities on Hawaii might have ceased when the

bodies were shipped to Maui without equivalent concerns being picked up by the Maui authorites, and that this might account for the lack of inclusion of the three names in any later list. Subsequently, however, an article was found in the 2 April issue of the Maui News indicating that Duhas, who was identified, probably correctly, as C. L. Duman, a seaman, and Lausa and Lee, who were identified as stevedores, had been picked up in Hilo harbor by the ship, identified as the "Brigham Victory", as it was attempting to get under way, and that, although suffering from shock and exposure, the three men survived. No death certificates were found to contradict the report of their survival.

It is clear that several persons died in hospitals as the result of injuries or exposure resulting from the tsunami. In some cases the deaths occurred after a lapse of several days. Even in these cases the deaths should certainly be attributed to the tsunami, although it is possible that they were not counted in the numbers of identified dead published in some newspapers issued after the dates of death or in some standard sources. Persons in this category include: Elizabeth N. Mendez of Hamoa, Maui, according to the Advertiser and the Star-Bulletin of 8 April; Bella Castro of Hala, Maui, according to the Star-Bulletin of 8 April; and Chiye Narimatsu of Hilo, according to the Star-Bulletin of 16 April. The reports of their deaths merited only a (c) rating because of the small number of lists in which their names appeared. However, death certificates were found for Mendez and Castro, so that their deaths were considered certain in the final conclusions. No death certificate was found for Narimatsu and there is no card for her in the BOH card file. However, the circumstances reported in the newspaper seemed to justify considering her death probable in the final conclusions.

According to the Star-Bulletin of 16 April, Toraki Matsumoto of Hilo, earlier reported missing, died of a stroke, "which officials said was brought about by wave injuries", after his release from the Hilo hospital. His death as a result of the tsunami was initially rated (b) in the newspaper-list analysis. In the certificate of his death, which occurred on 6 April, "cerebral apoplexy" was entered for the direct cause of death, "6 yrs." was entered for the duration of this condition, and "1 April" was entered as the date when the victim first came under the care of the physician who signed the certificate. With the confirmation by the Registrar of Vital Statistics that a case of cerebral apoplexy could not continue over a period of 6 years, and that a 6-day duration was probably intended (although the actual duration from 1 to 6 April was only five days), Matsumoto's death was considered a certain but indirect result of the tsunami.

The extent to which the names of Norman and Patrick for Nakano children were included in the newspaper lists of those missing at Laupahoehoe or on Hawaii warranted ratings of (b) to the first name and (a) to the second. However, a birth certificate was filed for a Nakano child whose first and middle names were given as Norman and Patrick. Hence only Patrick N. Nakano was finally considered missing, his disappearance being considered certain.

Entries in newspaper lists of the dead at Hilo were sufficient to warrant assignment of an (a) rating to the death of Alice Leite and a (c) rating to the death of Alice Yamada. No death certificate seems to have been filed bearing either name. However, the final check of the CRC computer file revealed documents indicating that Alice Leite was the wife of a John Leite and the mother of Allison Leite, a certain victim of the tsunami. Hence in

the final conclusions, the death of only Alice Y. Leite was considered probable, and Alice Yamada was not considered an additional victim of the tsunami.

There were at least two cases of mistaken identification of bodies. At different times, two different bodies recovered at Hilo were identified as that of Bong Ha Yee. With the recovery and identification of the second on 12 April, according to the Star-Bulletin of 16 April, the identification of the first body was tentatively changed to that of Basilio Miranda, listed earlier as missing. Death certificates were found for both Bong Ha Lee [Yee] and Basilio Mirando [Miranda]. A body apparently found at Hilo on 1 April was, by the morning of 2 April, identified as that of a Mrs. Ueda. However, according to the Tribune-Herald of 5 April, Mrs. Ueda "was found to be alive and safe, and the person buried as Mrs. Ueda will go on the records as unidentified". Two death certificates were found for Tokue Hirabara of Hilo, the second being identified as a correction of the first. Death certificates were also filed for three unidentified children at Hilo, two male and one female. However no death certificate was found for either a Mrs. Ueda or for an unidentified adult of either sex.

It appears that Hilo was the only place where bodies recovered remained unidentified. The minimum number is three, those of the children for whom death certificates were filed. The probable number is four, including the body of the woman once identified as Mrs. Ueda. The number was given as five in the Star-Bulletin of 3 April, but several bodies were identified after that date. Hence the number of 5 unidentified bodies was considered in the final conclusions merely a possible maximum.

Final statistical analysis

Fatalities in the islands as a whole

For comparison with the three groups of fatality statistics shown first in table 2 and already discussed, two more groups of statistics for the islands as a whole have been added to the table on the basis of the results of the analysis of the lists of fatalities:

4) the numerical implications of the results of the analysis of the newspaper lists in the form of the numbers of identified dead and missing rated (a); the successive cumulative sums of those numbers with the equivalents rated (b), (c), and (d); and the totals of the presumed dead calculated as sums of the numbers of identified dead and the numbers of the missing.

5) the numerical implications of the conclusions reached from analyis of all of the evidence, other than that in the standard sources, in the form of three numbers for each of the fatality categories: a minimum number represented by the number of individuals considered certainly in the category; a probable number calculated as the sum of the minimum and the number of individuals considered probably in the category; and a maximum calculated as the sum of the probable number and the number of individuals considered possibly in the category.

Although, as indicated in table 2, the total of the missing and the dead rated (b) and higher in the newspaper-list analysis differs by only two from the total of those identified for whom death certificates were issued, comparison of the names rated (a) and (b) with those on the death certificates indicated significant differences. For 113 persons there were both reports of death in death certificates and (a) or (b) ratings of deaths. However, of the total of those reported dead in death certificates, seven received only (c) ratings, six were reported only as missing in the newspapers, and three were not included in any newspaper list; and no death certificates seem to have been filed for six persons whose deaths were rated (a) and two whose deaths were rated (b).

The number of 12 infant deaths reported in the BOH annual report was found to be one greater than the number of children, dead and missing, for whom were filed death certificates showing ages less than one year.

As the table indicates, the total of the presumed dead reported in the standard sources of set 1, 159, is identical to the total considered most probable excluding the one indirect death at Hilo. Considering the range of uncertainty in the total, the difference of two between that number and the number reported in the standard source of set 3 cannot be regarded as significant, and the latter number would differ by only one from the most probable total if the one indirect death were included in the latter. In the absence of any grounds for preferring the set-3 number, the number of 159 was accepted as the most probable total of the presumed dead counting only those whose deaths are directly attributable to the tsunami, as indicated in the sixth group of statistics shown in table 2.

It will be noted that the minimum number for the total presumed dead suggested by the analysis is slightly smaller than the number reported in the standard source of set 2 (the Board of Health) (and would be only one smaller if the one indirect death were included in it), and that the maximum number suggested by the analysis is two greater than the number reported in the standard sources of set 4. It seems unlikely that the smaller of the actual numbers could have been less than the smallest reported in the standard sources or that the larger of the actual numbers could have been greater than the largest reported in the standard sources. Hence the set 2-number of 142 was accepted as the minimum possible total including the indirect death; and the set-4 number of 173 was accepted as the maximum possible total excluding the indirect death.

The acceptance of these numbers, it may be noted, is inconsistent with neither the listing in table 3 nor with the acceptance of the most probable numbers shown in table 2 for the identified dead and the missing. It implies merely that, out of the 19 individuals who are listed as probably dead or missing in table 3, at least one, unidentifiable, definitely did die or disappear; and that, out of the 16 listed in table 3 as possibly dead or missing, at least 2, unidentifiable, did not actually either die or disappear.

The number of 115 known dead reported by Shepard, Macdonald, and Cox (1950), it may be noted, is identical to the number of death certificates in which deaths were attributed directly to the tsunami and, hence, to the accepted minimum number of identified dead. The number of 44 missing reported by Shepard, Macdonald, and Cox, although within the range of numbers for the

missing reported in the newspapers and within the range accepted as possible, is 6 greater than the number accepted as most probable.

Because the range of uncertainty in the number of fatalities on Hawaii is greater than the ranges in the case of the other islands, the islands other than Hawaii will be treated first in discussing the breakdown of the totals for the islands as a whole.

Fatalities on Maui

In all of the newspaper issues published after 7 April that reported numbers for the dead and missing or listed them, the sum of the numbers was 14, agreeing with the number given in each of the three standard sources reporting the total. The number 14 is also that suggested as most probable by the analysis of the news lists and of the combination of newspaper and BOH evidence. That number, and its components, 11 identified dead and 3 missing were, therefore, accepted as definitely valid, although the number of the missing had been rated only probable and not certain using the general criteria.

The only number reported in a standard source for the fatalities at a specific place on Maui, the number reported in Shepard, Macdonald, and Cox (1950) for the deaths at Keanae, agrees with the number indicated by death certificates and newspaper lists.

Fatalities on Oahu

The newspaper evidence and that provided by death certificates confirm the validity of the total of 6 dead on Oahu reported in the standard source of set 3 (Thrum's Annual) and suggest strongly that there were no missing persons. The number three reported in the standard sources of set 1 seems, therefore, clearly to be erroneous, resulting probably from counting twice the children whose deaths were reported at both Kahana and at "Kalama Bay". The death certificates and other evidence confirm the deaths of the three children at Kahana, the three whose deaths were reported by Shepard, Macdonald, and Cox (1950).

In reporting the deaths of five persons at Kaena Point, the Eastern Section of the Seismological Society of America seems clearly to have referred to five of the men serving at an Army radar station near the point and near Mokuleia. The Star-Bulletin in one of its 1 April editions reported all five missing and in another reported one missing and four injured. However, the Advertiser reported the next day that four of the men thought missing had been located leaving but one unaccounded for. Whether the fifth man was later located on land or picked up at sea is not clear. That he ceased to be considered missing is indicated, however, by the facts that, in the lists of the missing in the Star-Bulletin issue of 3 April, there was no entry for Oahu and that no issue of either Honolulu paper published thereafter either reported or listed a person missing.

Fatalities on Kauai

Although the number of 15 given in the standard sources of set 1 for the dead on Kauai was also reported as if the number of identified dead in some

newspaper issues and represented in the number of identified dead listed in some others, all of the newspaper issues published after 5 April reported two or three missing and indicated that the total of the presumed dead was 17, 18, or 19. There were 17 death certificates filed from the island, including one for a man whose body was not recovered, and the numbers 16 for the identified dead and one for the missing are suggested by the analysis as the most probable numbers. The number 17, which was that reported for the total by the standard source of set 3 (Thrum's Annual) was, therefore, accepted as both the minimum possible number and the most probable. On the basis of the evidence in the newspaper lists, however, maximum numbers of 17 for the identified dead, two for the missing, and 19 for the total were accepted as possible.

Fatalities on Hawaii

Although the totals of the dead and missing reported in or implied by lists appearing in newspapers issued after 5 April ranged from 126 to 159, the total of the deaths and disappearances rated (a) in the analysis of the newspaper lists was only 110, the total rated (b) or higher was only 131, and even the total rated (c) or higher was only 145.

Death certificates were filed for 82 identified bodies, not counting that of the man whose death is attributable to the tsunami only indirectly, 3 unidentified bodies, and 21 missing persons. There were entries in the BOH card file for an additional 8 missing persons. From the geographic distribution and the ages of the dead and missing, it appears that the BOH records pertain in total to at least 106 and perhaps as many as 114 persons, again not counting the one indirect death.

The results of the analysis of the combination of BOH and newspaper evidence, again taking place of reported death or disappearance into account, suggested, in addition to the 107 certain total deaths regarded as the minimum possible, a more probable total of 122, and a possible maximum of 136.

The results of the analysis were accepted so far as the probable total is concerned, although the number, excluding the indirect death, was one greater than the total of 121 reported in the standard sources of set 1, and although the number increased to include the indirect death is one smaller than the total of 124 reported in the standard source of set 3. The maximum suggested by the analysis also was accepted. However, the minimum number suggested by the analysis of the combined evidence for Hawaii alone, would have been inconsistent with the combination of the minimum accepted for the islands as a whole and the total fatality statistics accepted for the other islands. The minimum accepted for the island of Hawaii was the difference of 113 between the minimum accepted for the islands as a whole and the sum of the maxima accepted for Maui, Oahu, and Kauai.

The only fatalilty statistics appearing in a standard source for an individual place on Hawaii are those pertaining to Hilo. The unreliability of the three of these statistics reported in standard sources of set 4 may easily be demonstrated. The number of 173 deaths reported in the Hawaiian tsunami catalogs clearly represents a mistaken attribution to Hilo of the number occurring in the islands as a whole according to other set-4 sources. The numbers of 58 and 68 deaths reported by the Eastern Section of the Seismological Society and in the Pacific tsunami catalog, respectively, are

smaller than the number of identified deaths at Hilo recorded in death certificates. However, the number reported in Shepard, Macdonald, and Cox (1950), 96, agrees with the total presumed death number suggested as most probable in the analysis of the combination of BOH and newspaper evidence.

Persons injured

As indicated in table 2, the numbers of persons reported in the newspapers to have been injured by the tsunami ranged very widely, and even the smallest of the numbers reported was significantly greater that the 163 reported in the standard sources of set 1. In part, the lack of correspondance may result from the inclusion of persons whose injuries were slight in the newspaper counts and the restriction of the set-1 count to persons hospitalized. In part, the diversity of the numbers reported in the newspapers probably results from the incompleteness of reports at the times of publication of early newspaper issues. It probably also results in part from the publication in some of the newspapers of poorly supported estimates not identified as such. (In addition to what were reported as if precise numbers, the newspapers included estimates phrased in terms of tens, scores, or hundreds).

The number of 100 injured on Hawaii reported by the Eastern Section of the Seismological Society was probably based on an early, incomplete report, as were other numbers reported in that source. The number of 153 reported by the Red Cross is probably more reliable, at least as it relates to those hospitalized, as are the Red Cross numbers of 2 on Maui and 8 on Kauai.

The Red Cross was clearly in error, however, in reporting that there were no injuries requiring hospitalization on Oahu. As reported in the Star-Bulletin of 1 April, three members of the Wix family (both parents and a daughter) whose home was near Kaloko Point, between Sandy Beach and Makapuu Point, required at least emergency hospital treatment, as did a man who lived in Niu. In addition, ambulances were reported to have transported persons injured on the Mokuleia coast to hospitals at Wahiawa -- presumably some of the personnel of the Army radar station. The most reasonable number of those on Oahu who were injured seriously enough to require hospitalization appears to be the 5 reported in the Star-Bulletin of 5 April.

Summary and conclusions

In summary, the conclusions reached in this study are that most probable number for the deaths caused directly by the 1946 tsunami in the Hawaiian Islands, including persons missing and presumed dead, was the 159 reported in the Red Cross report on the tsunami and by Shepard, Macdonald, and Cox (1950). It is almost equally probable that the number including a death indirectly attributable to the tsunami was the 161 reported in Thrum's Annual. The numbers reported in the Board of Health annual report and in the standard sources of set 4, 142 and 173, are regarded respectively as possible minimum and maximum totals. The number of persons with injuries severe enough to warrant hospitalization was probably about 163, the number reported by the Red Cross.

The numbers for each of the casualty categories accepted for the islands as a whole, the accepted equivalents for each of the islands, and accepted

breakdowns of the numbers of the fatality categories by place, are compiled in table 3.

In the case of 12 of the 15 places at which there were fatalities or presumed fatalities, the contemporary evidence of the total of the dead and missing was found consistent enough to warrant accepting as definite a single value. In the case of Laupahoehoe, Hawaii, and Haena, Kauai, however, there are differences of one between the minimum and the maximum values accepted, and in the case of Hilo, Hawaii, the range of uncertainty is 23, almost a quarter of the most probable number.

The uncertainties remaining in the accepted values result from inconsistencies in the contemporary evidence but reflect very incompletely the extent of the inconsistencies. Successive newspaper reports of the numbers of casualties differed far more than can be accounted for by the changes in numbers expectable with the finding of additional bodies, the identification of bodies found with persons earlier considered missing, and the finding that other persons earlier considered missing were alive and well. Much of the confusion obviously resulted from the use, in many cases, of more than one name for a single person. There were inconsistencies even in the filing of death certificates. Physicians serving in Kalihiwai, Kauai, and in Hilo filed certificates for persons missing as well as those whose bodies were not recovered, but those serving in other communities did not. No death certificates were filed for seven of the persons considered probably among those whose bodies were identified. Whether certificates for them were never made out or lost before filing cannot, of course, be known.

The conclusions are inescapable that the magnitude of the catastrophe was so great as to cause a partial breakdown in the system for recording deaths and keeping track of the missing, especially at Hilo, and that the newspapers not only accepted errors made by officials but compounded them in their efforts to report promptly on the effects of the tsunami as the information on the effects became available.

Table 3. Final conclusions as to numbers of casualties, 1946 tsunami.

Place	Identified dead			Unidentified dead			Total known dead			Missing			Total presumed dead			Injured #
	Min	Prb	Max	Min	Prb	Max	Min	Prb	Max	Min	Prb	Max	Min	Prb	Max	
HAWAII																
Hilo	78*	83	85	3	4	5	81*	87	90		13	25	87*	96	110	
Laupahoehoe	3	4	4				3	4	4	21	21	21	24	25	25	
Anaehoomalu	1	1	1				1	1	1				1	1	1	
Island	82*	88	90	3	4	5	85*	92	95	21	34	46	113*	122	136	153
MAUI																
Hamoa	7	7	7				7	7	7	3	3	3	10	10	10	
Keanae	2	2	2				2	2	2				2	2	2	
Paia	1	1	1				1	1	1				1	1	1	
Mala	1	1	1				1	1	1				1	1	1	
Island	11	11	11	0	0	0	11	11	11	3	3	3	14	14	14	2
OAHU																
Kakana	3	3	3				3	3	3				3	3	3	
Punaluu	1	1	1				1	1	1				1	1	1	
Kahuku	1	1	1				1	1	1				1	1	1	
Waianae	1	1	1				1	1	1				1	1	1	
Island	6	6	6	0	0	0	6	6	6	0	0	0	6	6	6	5
KAUAI																
Haena	7	7	8				7	7	8			1	7	7	9	
Wainiha	3	3	3				3	3	3				3	3	3	
Kalihiwai	5	5	5				5	5	5	1	1	1	6	6	6	
Hanamaulu	1	1	1				1	1	1				1	1	1	
Island	16	16	17	0	0	0	16	16	17	1	1	2	17	17	19	8
ALL ISLANDS																
Totals	115*	121	124	3	4	5	118*	125	129	25	38	51	141*	159	173	168

* Numbers do not include one death at Hilo definitely but indirectly attributable to the tsunami.

Probable approximate numbers of persons with injuries severe enough to require hospitalization.

TSUNAMI OF MAY 1960

Background and casualty reports in standard sources

The 1960 tsunami, which originated off the coast of Chile, arrived in Hawaii a little before 1:00 am. on the 23rd of May. It caused extensive damage at Hilo, significant damage elsewhere on Hawaii and on Oahu, and some damage on other islands. Although a warning was issued by the Seismic Sea Wave Warning System that had been established by the U. S. Coast and Geodetic Survey in 1948, the tsunami caused many casualties in Hilo.

Essentially two sets of casualty statistics have been reported for the tsunami in standard sources, as indicated in table 4. If as suggested by the table, the 57 deaths reported by the Department of Health represented bodies recovered and identified and the 61 reported by the Red Cross and other standard sources included persons missing and and presumed dead, the reports are not mutually inconsistent. To investigate whether the numbers actually represented these categories of fatalities, reference was made to contemporary reports of the same sorts as those consulted in the case of the 1946 tsunami.

Contemporary records

The records of the State Department of Health (DOH), which had replaced the Territorial Board of Health, included the death certificates filed from Hilo within the month following the occurrence of the tsunami, and an index of death certificates for the year 1960. Access to the DOH files was provided by courtesy of George Tokuyama, Registrar of Vital Statistics.

Table 4. Numbers of casualties reported in standard sources, 1960 tsunami.

Source set	Known and identified dead			Missing	Total presumed dead	Injured
	Male	Female	Total			
1	35	22	57			
2					61	282 *

Sources

Set

1 Hawaii Department of Health, 1960.

2 Red Cross (Wall, 1960).
U. S. Coast and Geodetic Survey (Talley and Cloud, 1962).).
Pacific tsunami catalog (Iida,Cox, and Pararas-Carayannis, 1967).
Hawaiian tsunami catalogs (Pararas-Carayannis, 1969; Pararas-Carayannis and Calebaugh, 1977).

* Number of injured reported only in Pacific tsunami catalog.

The newspapers in which information was sought were the two major Honolulu newspapers, the Advertiser and the Star-Bulletin, and also the Hilo Tribune-Herald. As in the case of the 1946 tsunami, casualty information was published in these newspapers in the form of both lists of individual victims and summary statistics. There was information of one or both forms in practically every issue of each paper published from the 23rd of May until the end of the month, and summary statistics were published also in the Star-Bulletin on the 22nd of June 1960.

Death certificates overlooked at the time of an initial search of the DOH files were found later, through the use of the DOH index, for a few persons included in newspaper lists of the dead.

Analysis of casualty records

Fatalities at Hilo

Like the 1946 casualty reports, the 1960 casualty reports were subjected first to purely numerical analysis. As suggested by table 5, the extent of inconsistency found in this analysis was far less than that found in the 1946 case. The number of death certificates eventually found was 57; The numbers of the known dead reported in successive issues of the newspapers converged systematically toward that number; the totals of the missing and the known dead converged almost as systematically toward the number 61; and the number of the known dead and the sum of that number reported in the Star-Bulletin summary of 22 June were 57 and 61 respectively. However, to confirm the validity of these statistics, the names on the death certificates and those in the newspaper lists of the dead and missing were compared.

The name comparison indicated inconsistencies of the same sort as, although less extensive than, those found in the study of the 1946 casualties. Hence, as in that study, reliability ratings were attached to each of the names included in the newspaper lists--the criteria for an (a) rating, being, for example, inclusion of the name in each of three lists, those in the Advertiser of 25 May, the Star-Bulletin of 26 May, and the Herald-Tribune of 27 May.

As indicated in table 5, the numbers of the known dead and missing with (a) ratings were, respectively, the expected 57 and 4. However, no death certificate was found for one woman whose death was rated (a) on the basis of the newspaper lists and one woman for whom a death certificate was found was not included in any newspaper list of the dead or missing. Although the first name of both women was Mary, their family names and ages were quite different. Hence, a higher probability that the number of known dead was 58 than 57 was suggested by the application of the criteria used generally in the analysis of the combination of newspaper and health-agency information concerning the 1946 fatalities.

In spite of this result of the inconsistencies in reporting the names of the victims of the tsunami, it was finally concluded, not only that it caused at least 57 known deaths but that this was the most probable number, and that the (a) rated death of the woman for whom no death certificate was filed was merely a possible additional one. It was concluded that the number of the missing was definitely 4.

Table 5. Numbers of casualties due to the 1960 tsunami as reported in various sources and derived by analysis.

	Dead, unspecified	Dead, identified	Dead, unidentified	Dead, total known	Missing	Dead, presumed total	Injured
Standard sources							
Set 1		57		57			
Set 2	61					61?	282
Department of Health records							
Death certificates and index		57			8		
Newspaper reports							
26 to 29 May 1960		48 - 56		48 - 56	5 - 13	59 - 61	43 - 45
22 Jun 1960		57		57	4	61	
Analysis of newspaper lists							
Reliability rating:							
a		57		57	4	61	
b or higher		57		57	4	61	
c or higher		58		58	7	65	
d or higher		60		60	10	70	
Combined evidence							
Minimum		57		57		57	
Probable		58		58	4	62	
Maximum		58		58	4	62	
Final conclusions							
Certain		57		57	4	61	
Possible		58		58	4	62	43

Numbers of persons injured reported in newspapers of 23 - 24 May.

The persons whose deaths or disappearances resulted or may have resulted from the tsunami are listed in the appendix.

Other casualties

The tables of the Department of Health annual report from which the fatality statistics of set 1 were drawn were qualified as including only civilian deaths. No evidence was found in contemporary records that any military personnel in Hilo were victims of the tsunami. However, according to the Advertiser of 26 May, the occurrence of the tsunami was associated with the death of a marine on Oahu. This was M/Sgt. John T. Pracanica, 33, who fell dead of a heart attack just after he had taken his wife and children to high ground at the Kaneohe Marine Corps Air Station on Mokapu peninsula.

There are some similarities between Pracanica's death and that of Toraki Matsumoto in Hilo in 1946. However, Matsumoto's death could properly be considered an indirect, although delayed, consequence of the 1946 tsunami because it resulted from a stroke attributed to injuries that he received, apparently, while rescuing his family from the tsunami. There is no evidence that Pracanica's family was actually threatened by the tsunami, and his death may actually have occurred before the tsunami arrived. Hence his death is more properly considered an indirect consequence of the tsunami warning than of the tsunami itself.

No contemporary documentation has been found supporting the report in the Pacific tsunami catalog that 282 persons were injured at Hilo, or for that matter anywhere in Hawaii. The only available contemporary statistics on non-fatal casualties seem to be the much smaller numbers appearing in or based on newspaper accounts published on the day of the tsunami's arrival and the next day. Of these numbers, the 43 derived from an article in the Advertiser of 24 May seems the most reliable equivalent of the numbers of the injured accepted for the 1946 tsunami, because it represents a count of the names of individuals who had been hospitalized because of injuries caused by the tsunami according to lists published hospital by hospital in the newspaper. It is doubtful that any injured persons would have been hospitalized later.

Conclusions

The conclusions reached as to the casualties associated with the May 1960 tsunami are summarized in table 6.

Table 6. Final conclusions as to numbers of casualties, 1960 tsunami.

Place	Known and identified dead		Missing	Total presumed dead		Injured
	Certain	Possible		Certain	Possible	
Casualties resulting directly from the tsunami itself						
HAWAII						
Hilo	57	58	4	61	62	43
Casualty resulting indirectly from the tsunami warning						
OAHU						
Kaneohe MCAS	1					

1975 TSUNAMI

The tsunami occurring before dawn on 29 November 1975 accompanied an earthquake centered on the southeast coast of Hawaii that was very similar to that which was accompanied by the tsunami of 2 April 1868; and the two tsunamis were very similar in runup pattern.

Although a tsunami alert was issued by the State Civil Defense Division on the basis of the occurrence of the earthquake, and coastal sirens were sounded on Hawaii and Maui, the tsunami caused two fatalities. According to Cox and Morgan (1977):

> The two deaths associated with the earthquake occurred among the 34 persons who were camping in a National Park campground at Halape on the Kau coastline, accessible only by trail. The campers, including a party of Boy Scouts, were sleeping on the beach when the tsunami swept over them, tossing them against rocks and trees (Hon. Star-Bulletin, 24 [sic, actually 29] Nov. 1975). The scoutmaster was one of those killed, becoming, according to one account, "a victim of a freak aftershock of shock" (Star-Bull. and Adv., 30 Nov. 1975), specifically a rock fall (Loomis, 1976). However, according to his death certificate, he was drowned. The body of the other victim was never recovered, but according to the death certificate, he was presumed "carried away by waves." Hence, officially both are regarded as victims of the tsunami rather than of other earthquake-associated phenomena.
>
> An early report stated that thirteen campers were injured (Hon. Star-Bull., 29 November 1975). A later count indicated that the number was nineteen, and that seven required hospitalization (Tilling et al., 1976).

Cox and Morgan (1977) cited newspaper reports and the paper by Tilling et al. (1976) to the effect that the sirens were not sounded early enough to have warned people of the waves before they arrived on the Kona coast of Hawaii where, fortunately, they caused no casualties. Issuance of a timely warning in Halape would have been impossible.

The scoutmaster who died was James A. Mitchell, a Hilo surgeon. The missing person was Michael Cruz (Advertiser, 1 Dec.; Star-Bulletin, 1 Dec.)

OTHER TSUNAMIS AND THE TSUNAMI CASUALTY RECORD GENERALLY

Tsunami of March 1957

In addition to the six tsunamis for which Schmitt (1969) reported fatalities and the seventh that occurred subsequent to the publication of Schmitt's paper, there has been at least one more with which known fatalities were associated. This was a tsunami that arrived on 9 March 1957 from the central Aleutian Islands and caused extensive damage, particularly on Kauai. The deaths associated with it were those Sarah Park, a reporter for the Star-Bulletin, and Paul Beam, an advertising man. Beam was piloting a light airplane for Park and a photographer for the newspaper, Jack Matsumoto, so that they could observe and photograph the impact of the tsunami waves on the coast of Oahu, when the plane crashed into the sea off Laie, Oahu. Park died at the time of the crash or immediately thereafter. Beam died the next day of injuries sustained in the crash. Matsumoto, although hospitalized for injuries, survived. (Honolulu Star-Bulletin, 9 March, 11 March; Sunday Advertiser, 10 March; Honolulu Advertiser, 11 March).

The two deaths cannot be attributed directly to the tsunami, and there is no evidence in the newspaper accounts of the incident suggesting that the tsunami in some way caused the crash of the airplane. It is clear, however, that the airplane trip was undertaken for the sole purpose of observing and photographing the tsunami and its effects. The warning that had been issued by the Seismic Sea Wave Warning System both provided the impetus for the trip and made it possible for the plane to be off the Laie coast when the waves were washing that coast. The deaths, and Matsumoto's injuries may, therefore, be considered indirect effects of the warning of the 1957 tsunami in much the same way that Pracanica's death may be considered an indirect effect of the warning of the 1960 tsunami.

The casualty record

The year 1837 is commonly taken as the beginning of the period during which the record of significant tsunamis in Hawaii may be considered reasonably complete. However, there are reasons for believing both that the record is complete for a longer period with respect to tsunami fatalities at certain places in Hawaii and that the record since 1837 may not be complete with respect to tsunami fatalities occurring in the islands in general.

A law requiring the collection of vital statistics by tax officials was first adopted in the kingdom of Hawaii in 1840. Filing of an "annual bill of mortality" became a responsibility of the Minister of Public Instruction in 1846; provision was made for appointment of local registrars of vital statistics in 1850; and the reporting of deaths to the registrars became a legal requirement in 1859. Under the Republic of Hawaii, the collection of birth and death certificates became a function of the Board of Health when, in 1896, it was authorized to appoint the local registrars (Schmitt, 1968). Death certificates were originally kept in the districts where they were filed. Not until much later were the district files transferred to Honolulu; and there are gaps in the files then transferred (George Tokuyama, State Registrar of Vital Statistics, personal communication).

As has been noted earlier, there is evidence of irregularity in the filing of death certificates even for the 1946 tsunami. It is possible that the report of the sheriff in Hilo to the Marshall in Honolulu concerning the fatalities of the 1877 tsunami was based on a file of death certificates, but there is no evidence of this in the report. The records of the fatalities of the tsunamis of 1837 and 1868 used in the preparation of this report and of all earlier reports cited were compiled by much less formal means in which missionary contributions were particularly important.

The first of the Christian missions were established in 1820. It is very unlikely that a significant loss of life could occur after about 1825 at or near one of the mission stations such as those at Honolulu on Oahu, Lahaina and Wailuku on Maui, and Hilo and Kealakekua on Hawaii, in association with an unusual geophysical event like a tsunami, without the event and the loss being brought to the attention of the missionaries at the station and incorporated by them into the composite record now available.

Although what was probably a tsunami of unknown origin had affected the Kona coast of Hawaii in 1813 or 1814 (Iida et al, 1967), the earliest definitely datable tsunami in the Hawaiian record was one arriving from Chile on 12 April 1819. The only available contemporary record of this tsunami in Hawaii is that in the diary of Don Francico de Marin (Gast and Conrad, 1973). The record has been assumed by geophysicists (Shepard et al., 1950; Iida et al., 1967, Pararas-Carayannis, 1969; Pararas-Carayannis and Calebaugh, 1977) to pertain to the west coast of the island of Hawaii. It actually pertains, however, to Honolulu where Marin was a resident (Gast and Conrad, 1973). The tsunami was too small there to have caused fatalities. The report to Armstrong (1838) that a phenomenon like, but less severe than, that of 1837 had occurred at Kahului before the death of Kamehameha the Great, and a report to Coan (1838) that a similar phenomenon had occurred in Hilo in the days of Kamehameha very probably related to the 1819 tsunami. According to the reports the phenomenon resulted in no fatalities at either place.

It seems safe to assume that there have been no tsunami fatalities at Honolulu since 1819 and that the records of tsunami fatalities at Kahului and at Hilo discussed in this report are complete for the period beginning in that year.

It cannot be assumed, however, that either the missionaries or government officials were necessarily informed of all losses of life occurring at remote places during the 19th century, particularly the early part of that century. No definite maximum could be established in this study for the number of fatalities that might have been caused by the April 1868 tsunami; and, even if maxima had been established for the numbers of fatalities that might have possibly have been caused by each of the other seven tsunamis known to have caused fatalities in Hawaii at each of the places where there were known fatalities, the sums of the maxima for each tsunami would not neccessarily represent an upper limit to the number of fatalities that might possibly have resulted from that tsunami. Furthermore, it is possible that, in addition to those seven tsunamis, there were others that caused fatalities in Hawaii. Hence the no definite upper limit can be set to the number of fatalities that may possibly have been caused by historic tsunamis in Hawaii.

SUMMARY AND CONCLUSIONS

Tsunami fatalities

In summary, seven tsunamis are known to have caused fatalties in Hawaii, the numbers ranging from one for the Chile tsunami of 1923 to, probably, 159, for the Aleutian tsunami of 1946. The most probable total for the fatalities directly attributable to historic tsunamis, including the missing and presumed dead, is 290, but the total may have been as small as 269 or as large as or larger than 309. These numbers do not include one fatality indirectly attributable to a tsunami, the death of a Hilo man from a stroke brought on by his efforts in saving his family from the 1946 tsunami. They also do not include fatalities attributable to tsunami warnings as distinct from those attributable to the tsunamis for which the warnings were issued.

The most probable total, the minimum, and so far as possible the maximum numbers, are broken down by tsunami and by place of death in table 7. As will be seen, 85 or 90 percent of the fatalities have occurred at Hilo, and losses of life have resulted from more tsunamis at Hilo than at any other place. The only fatal tsunamis that did not cause deaths at Hilo were the two of local origin, those of 1868 and 1975, which caused deaths on the Kau-south Puna coast of Hawaii alone.

The fatality totals in table 7 have not been broken down into the categories of known and identified dead, known but unidentified dead, and missing and presumed dead, because distinctions between these categories were rarely made in available records of the tsunamis of the 19th century. In this study it has been assumed that, in the absence of contradictory information, a number of fatalties reported without specification as to category represented the total of the known and identified dead and the presumed dead. It is possible, however, that some of the numbers reported without such specification represented merely the identified dead and did not include persons missing and presumed dead.

Relation of numbers injured to numbers of fatalities

In estimating the effectiveness of tsunami warning systems, Cox (1977 a, 1977 b, and 1984) assumed that, on the average, tsunamis might cause half as many non-fatal casualties as fatalities. A ratio twice as great is suggested by this study.

Even in the case of the best documented tsunamis the numbers of persons injured must be regarded only as approximations. The numbers accepted in this study for the 1946 and 1960 tsunamis, 168 and 45, respectively, refer to persons whose injuries were severe enough to warrant their hospitalization. For each of the tsunamis of 1877 and 1975 the number acceoted for those with injuries of comparable severity is 7.

The lack of available reports of the numbers of persons injured by other tsunamis tsunamis cannot be taken as evidence that they caused no injuries. Hence totals of the available numbers of persons injured, by place or overall, would be meaningless. The combination of a total for the fatalities and a typical ratio of number injured to number killed would be as useful, however, in estimating the overall hazard of tsunamis to persons; and ratios of this

Table 7. Summary of tsunami fatalities in the Hawaiian Islands.

Totals of presumed deaths (sums of dead and missing) directly attributable to tsunamis. *

Place	1837 Nov 7			1868 Apr 2			1877 May 10			1923 Feb 4			1946 Apr 1			1960 May 23			1975 Nov 29			TOTAL		
	Min	Prb	Max	Min	Prb	Max	Min	Prb	Max	Min	Prb	Max	Min	Prb	Max	Min	Prb	Max	Min	Prb	Max	Min	Prb	Max
HAWAII																								
Hilo	11	14	15				5	5	5	1	1	1	87	96	110	61	61	62				165	177	193
Laupahoehoe													24	25	25							14	25	25
Ahaehoomalu													1	1	1							1	1	1
Kau				46	46	=48													2	2	2	48	48	=50
Puna					1	1																		1
Island	11	14	15	46	47	49	5	5	5	1	1	1	113	122	136	61	61	62	2	2	2	239	252	270
MAUI																								
Hamoa													10	10	10							10	10	10
Keanae													2	2	2							2	2	2
Paia													1	1	1							1	1	1
Kahului	2	2	2																			2	2	2
Mala													1	1	1							1	1	1
Island	2	2	2										14	14	14							16	16	16
OAHU																								
Kahana													3	3	3							3	3	3
Punaluu													1	1	1							1	1	1
Kahuku													1	1	1							1	1	1
Waianae													1	1	1							1	1	1
Island													6	6	6							6	6	6
KAUAI																								
Haena													7	7	9							7	7	9
Wainiha													3	3	3							3	3	3
Kalihikai													6	6	6							6	6	6
Nawiliwili													1	1	1							1	1	1
Island													17	17	19							17	17	19
HAWAIIAN ISLANDS as a whole	13	16	17	46	47	=49	5	5	5	1	1	1	141	159	173	61	61	62	2	2	2	269	291	=309

* Numbers tabulated do not include one death at Hilo, Hawaii, definitely but indirectly attributable to the 1946 tsunami or one death at the Kaneohe Marine Corps Air Station, Oahu, indirectly attributable to the warning of the 1960 tsunami.

Maximum possible total fatalities for individual islands and for islands as a whole may exceed totals of maxima shown for specific places.

sort have been calculated for the tsunamis for which numbers of persons injured are available. As might be expected, the ratios calculated for individual combinations of tsunami and place vary considerably--by a factor of 10 as shown in table 8. Considerig the ratio calculated overall, 1.0, it seems reasonable to assume for planning purposes that, in the long term, there will be equal numbers of deaths and persons with injuries sufficient to warrant hospitalization.

Table 8. Numbers of persons known to have been injured by tsunamis in Hawaii and ratios of those numbers to presumed death totals for the same tsunamis.

	1877 May 10		1946 Apr 1		1960 May 23		1975 Nov 29		Total	
	No.	Ratio	No.	Ratio	No.	Ratio	No.	Ratio	No.	Ratio
Hawaii	7	1.40	153	1.25	45	.74	7	3.50	212	1.12
Maui			2	.14					2	.14
Oahu			5	.83					5	.83
Kauai			8	.47					8	.47
Total	7	1.40	168	1.06	45	.74	7	3.50	227	1.00

Potential tsunami mortality

The total of the fatalities resulting from the seven tsunamis known to have caused fatalities in Hawaii is, in itself, a statistic that is of no use for planning purposes. Even the rate of tsunami-induced death averaged over the period during which the seven tsuamis occurred would be of no use because the population at risk has varied enormously over that period. However, a useful statistic may be computed in the form of a tsunami morbidity rate, that is a death rate per unit time per unit population calculated from the overall record.

A potential tsunami mortality rate was estimated by Cox (1984) assuming (as Cox, 1977 a and b) that, throughout the historic period, the population at risk from tsunamis along the shores of the Hawaiian islands has been proportional to the total defacto population of the islands, and assuming also that, although the 1960 tsunami caused a considerable number of fatalities, the number of fatalities would have been much greater if no warning had been issued for the tsunami.

The results of a re-estimation of the potential tsunami mortality rate in Hawaii are shown in table 9. The input statistics differ from those shown in the equivalent table in Cox (1984) (table 69) as follows:

1. The numbers of fatalities considered in this study to be the most probable for the tsunamis of 1886, 1946, and 1960 have been substituted for the numbers used in the 1984 calculation, 46, 173 and 57 respectively. (In the case of the 1946 tsunami, the number used in this study is that including the one indirect fatality in Hilo)

Table 9. Estimation of potential tsunami mortality rate in Hawaii.

Tsunami	Fatalities	Warning-system effect-iveness	Potential fatalities	De facto population, thousands *	Potential fatalities per thousand
1837 Nov 7	16	na	16	106	.151
1868 Apr 2	47	na	47	61	.770
1877 May 10	5	na	5	56	.089
1923 Feb 4	1	na	1	300	.003
1946 Apr 1	159	na	159	545	.292
1960 May 23	61	0.8	305	646	.472
1975 Nov 29	2	0.0	2	943	.002
Totals	291		535		1.776

Potential tsunami mortality rate per thousand per year
Average over 150-year record, 1837 to 1987 .0119
Average over 168-year record, 1819 to 1987 .0106

* From Schmitt, 1977; and Dept. of Plan. & Econ. Devel.(Anon., 1985).

2. A death associated with the 1957 tsunami, included in the 1984 table, has been excluded from table 9 because that death resulted indirectly from the tsunami warning than either directly or indirectly from the tsunami itself.

3. The value for the effectiveness of the warning of the 1960 tsunami that was actually used in the 1984 calculation, 0.8, has been substituted for the misleading rounded value of 1.0 shown in the 1984 table as printed. (In both the 1984 study and this one, the warning of the locally generated tsunami of 1975 was considered completely ineffective).

4. The period of record used in the 1984 study, the 145 years from 1837 to 1982, has been replaced by two alternatives, both ending in 1987.

5. The estimates of the population at the times of the 1960 and 1975 tsunamis have been revised slightly.

The shorter alternative, 150 years, beginning in 1837 with the occurrence of the earliest tsunami for which there is available a report of fatalities in Hawaii, is considered the period for which the Hawaiian record of readily observable tsunamis may be considered reasonably complete. The longer alternative, 168 years, beginning in 1819 with the occurrence of the earliest definitely datable tsunami in Hawaii, may be considered a period during which the record of tsunami fatalities in Hawaii is reasonably complete.

The assumption that the population at risk has been proportional to the total population would certainly be invalid with respect to specific places.

For example, the number of deaths caused by the 1975 local tsunami was a very small fraction of the number caused by the 1868 local tsunami, although the two tsunamis had almost identical sizes and runup patterns, in part because villages wiped out by the 1868 tsunami were never repopulated. For the islands as a whole, however, the assumption seems reasonable, and better than any alternative permitting estimation of tsunami morbidity that might be adopted.

As the table indicates, the mortality rates per thousand population per year calculated from the most probable numbers of fatalities for the historic tsunamis are 0.0119 for the 150-year period and 0.0106 for the 168-year period. If the possible minimum were substituted for the most probable total fatalities, the average calculated for the 168-year period would be 0.0105 per thousand per year. If the sum of the possible maximum numbers for the fatalities of the individual tsunamis at individual places were substituted for the most probable total, the average calculated for the 150-year period would be 0.0121. However, as noted earlier the total of the tsunami fatalities occurring during that period may possibly have been larger than that sum.

Even though the range of possible rates thus calculated is small, it cannot be assumed that any of the calculated rates is better than a very rough approximation. Use of the rounded value 0.01 is recommended primarily because it seems unlikely that a statistic better reflecting the overall long-term hazard of tsunamis to people can be calculated.

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APPENDIX

Individuals whose deaths or disappearances have resulted from or may have resulted from 20th century tsunamis in Hawaii.

Name	Age	Variant names	Var. ages	Death cert.
TSUNAMI OF FEBRUARY 1923				
HAWAII				
Hilo				
Dead	Certain			
Hamasaki, J.		(Search not made for death certificate)		
TSUNAMI OF APRIL 1946				
HAWAII				
Anaehoomalu				
Dead	Certain			
Kakazu, Uto	64	Kakazu, Mrs.Kana; Kakazue, Kana; Kokazu,Kama	63	3119
Hilo				
Dead	Certain, direct			
Abe, Gerald T.	0			3063
Abe, Vivian N.	3	Abe, Vivien		3067
Ah Fong, May	6	Afong, child, May		3001
Ah Fong, Richard	8	Afong, child, Richard		3000
Ah Fong, Shandry	28	Afong, Sandra (Mrs. Charles)	24	2999
Aguiar, Antone C.	38	Correa, Antone		2757
Albaros, Leon C.	43			3037
Amagos, Maxieo	56	Amagas, Maxieo		3021
Arita, Kichigoro	64			3006
Arita, Tsuru	59	Arita, T.	61	3044
Armitage, Betty	34		30	3024
Ayano, Mirei	54	Ayana, Meira; Meiri, Ayjano, Ayana; Mirei, Ayako		3059
Chow, Yet Hoong	68	Chow, Yet Hoon		2997
Chun, Kai	66		65	3011
Enaitano, Santiago	57	Santiago, Enitano	50,60	3034
Fujita, Suichi	60			3013
Fukui, Tsuru	43	Fukui, Tsune		3050
Fukumori, Haruko S.	38	Fukumori, Haruku; Tokumori, Haruku		3008
Furuya, Jack S.	34	Sekimura, Jack, Sakae		3004
Furuya, Rupert A.	1	Sekimura, Rupert		3049
Gomez, Gerardo A.	47		46	3303
Goto, Naoki	72	Gota, Naoki; Gota, Mali		3012
Hayashida, Harue N.	38	Hayashida, Harriet		3003

Name	Age	Variant names	Var. ages	Death cert.
1946 Tsunami, Hawaii, Hilo				
Dead	Certain, direct, continued			
Hayashida, Shigeru	3	Hayashida, Shigero		3002
Higashihara, Carol	0	Higashihara, Carrall; Shigashihara, child		3061
Higashihara, Harriet K.	5			3065
Hirabara, Tokue	69	Hirabara, Miss; Harabara, Mrs.		3060
Hiroshima, Masaichi	49	Hiroshima, Masaichi	50	3070
Ichinose, Sawa	62		63	3017
Ito, Ichitaro	83		82	3085
Iwaoka, Miles T.	0		4	3077
Izumi, Tomie	18			3066
Kahekili, George	17		18	3030
Kahoalii, William N.	31			3028
Kai, Edna F.	25	Kai, Edna M.	27	3071
Kai, Paul	34			3009
Kawaauhau, Sarah	1	Kauahau. Sarah		3042
Kawaha, Samuel K.	33		32	3029
Kinoshita, Makiyo	47	Kinoshita, Makayo, Shinmachi		3052
Kobayashi, Jane V.	28	Kobayashi, Mrs. Vincent		3055
Kobayashi, Takeji	1	Kobayashi, Kakeji		3056
Kono, Gunji	54			3079
Laanui, Rose K.	86			3016
Lee, Bong Ho	82	Yee, Bong Ha	70	3075
Leite, Allison L.	1		0	3041
Lorenzo, Mary	42			3058
Maldonado, Augustine	18	Maldonado, Agustine	53	3022
Maldonado, Odalia.	10	Maldonado, Linda	13	3014
Maldonado, Thomacia	42	Maldonado, Thomasia		2995
Martines, Augustine	7	Augustine, Martines		3027
Martines, Henry, Jr.	8	Martines, Henry J., Jr.		3036
Martines, Thomas	3			2993
Matsuno, Janice M.	0	Matsuno, Michiyo, Machiyo		3005
Miranda, Basilio	42	Mirando, Basilio	45	3078
Nakahara, Dennis H.	0	Nakahara, child; Nakahara, S.		3069
Nakaji, Chizuko	29	Nakaji, Chizako		3057
Nakaji, June S.	2		8	3040
Nakaji, Melvin T.	6	Nakaji, Melvin	5	3039
Naylor, Frederick	85	Naylor, Fred		2996
Nirei, Keiji	56			3068
Nuhi, Inez	1	Nuhi, Ines		3076
Nuhi, John, Jr.	5			3048
Nuhi, Victoria	6	Nuhi, Mrs. J		3047
Ragodo, Aquilino	38			3023
Rivera, Phillip	36			2994
Sakaguchi, Stanley S.	4		5	3007
Service, Jane	66			2998
Shimonaka, Asako	12	Shimonaka, Miss		3043
Tanaka, Eijiro	64			3072
Tanaka, Kura	58	Tanaka, Kuru		3053
Tateishi, Toshiro	71			3015

Name	Age	Variant names	Var. ages	Death cert.
1946 Tsunami, Hawaii, Hilo, Dead, Certain, Direct, continued				
Uno, Sadao	30	Uno, Sado		3051
Yamada, Kimiko	20			3062
Yamada, Toshi	57			3046
Yamamoto, Clifford	0			3031
Yamamoto, Kikujiro	80		79	3054
Yamamoto, Lorna	3			3032
Yoshiyama, Allan S.	3			3064
Unident.f.child				3035
Unident.m.child				3084
Dead	Certain, indirect			
Matsumoto, Toraki	68		65	3033
Dead	Probable			
Lagodo, Reyno				
Leite, Alice Y.	22	Yamada, Alice		
Matsuno, Mr.				
Napua, William	28		38	
Udo, Shizue				
Unident.adult				
Dead	Possible			
Narimatsu, Chiye	71			
Unident.adult				
Missing	Probable			
Afong, Charlie	30			
Afong (child)				
Cody, Meredith	3			*
Furuya, Myrna M.	2	Sekimura, Masuyo, Myrna M.		*
Hayashida, Seichi	1	Hayashida, Seiji		*
Kamimura, Asano		Kamimura, Asana		
Kobayashi, Harold G.	5			*
Kobayashi, Melvin	3			*
Kobayashi, Sadaji R.				*
Kobayashi, Tomaezen	7			*
Miura, Freddie	6			
Sumida, Jinjiro				
Yagi, Tsuyako	19			*

* No death certificate filed, but disappearance noted in BOH card file

Missing	Possible			
Afong, Loretta	4	Afong, child	2	
Alcontal, Francisco	35	Alconcal, Francisco		
Arruda, Manual	37			
Arruda, (son)				
Arruda, (son)				
Labia, Malaya	9			
Labia, Rosita				
Labia, Virginia	34			
Miyamoto, Noboru	27			
Terada, Takehara	8	Terada, Takeharu		
Umoto, Hanani	21			
Yamamoto, James Y.	47			

Name	Age	Variant names	Var. ages	Death cert.
1946 tsunami, Hawaii, continued				
		Laupahoehoe		
Dead	Certain			
Nakamura, Seishi	13	Nakamura, Seichi		3188
Yamamoto, Jitsumi	14	Yamamoto, Tatsumi		3190
Yokoyama, Janet H.	9	Yokoyama, Jane; de Caires, Janet Y	12	3186
Dead	Probable			
de Caires, Janet Y.	8	Yokoyama, Janet	12	
Missing	Certain			
Akiona, Daniel	15			3198
Bufil, Macario	15	Bucil, Macario		3185
de Caires, John N.	16		15	3192
de Caires, Madeleine J.	17		16	3191
Drake, Dorothy L.	22		21	3026
Fujimoto, Toshiaki	14		13	3183
Isaki, Shoso	16			3195
Ishizu, Mamoru	15	Ishiju, Mamuro; Ishizu, Mamoru		3187
Johnson, Fay B.	21	Johnson, Fay E.		3203
Kingseed, Helen J.	22	Kingsaed, Ellen	32	3205
Kruse, Fred W. L.	35			3204
Lacuesta, Anthony	16	Lacuesiq, Antone; Lachesta, Anthony		3177
Nakano, Florence M.	32	Nakano, Mrs. Peter		3199
Nakano, Janice M.	1	Nakano, child, Jeanette, or Janet	2	3201
Nakano, Patrick M.	0	Nakano, child (?)		3200
Nakano, Stella J.	3	Nakano, child	4	3202
Nakata, Matsuichi	17			3194
Sakamoto, Takayoshi	14	Sakamoto, Tokoyoshi	15	3184
Sunahara, Kiyoshi	16	Sunahara, Kiyoshi		3196
Tamamoto, Mitsuji	13	Tamamoto, Mitsugi		3193
Uyeno, Bert S.	14	Ueno, Satsuo, Satsuyo		3189
		MAUI		
		Hamoa		
Dead	Certain			
Atay, Kenneth K.	4	Ah Tai, Kenneth; Ah Pai, Kenneth		3127
Atay, Richard R.	6	Ah Tai, Richard; Ah Pai, Richard; Agay, Richard		3124
Cullen, Robert K., Jr	0			3126
Dusson, Maryann P.	65	Dusson, Mary Anne	58	3125
Kahula, Mary K.	57		50,51	3128
Mendez, Elizabeth N.	26			3131
Mendez, LeRoy K.	1			3130
Missing	Probable			
Ah Tai, Paul	2	Ah Pai, Paul		
Mendez, Junior	3			
		Keanae		
Dead	Certain			
Hardy, Walter A.	87		86,89	3129
Tau'a, Helen	49	Pau'a, Helen	48	3123

Name	Age	Variant names	Var. ages	Death cert.
1946 tsunami, Maui, continued				
		Paia		
Dead	Certain			
Idemoto, Gisaku	85	Idemoto, Gisebu; Ichimoto, Gisetu K.		2897
		Hala		
Dead	Certain			
Castro, Bella	87			2894
		OAHU		
		Kahana		
Dead	Certain			
Kanakanui, Ahone K.	0	Kanakanui, Aone, Mo.K.A.; Haaheo, child	1	2869
Kanakanui, Samuel P.H.	1	Kanakanui, Sam; Haaheo, Sam P.	2	2870
Kanakanui, William I.3d	3	Kanakanui, Isaac, Mo.Izaak III; Haaheo, child		2871
		Punaluu		
Dead	Certain			
Kikaha, Kanaka K.	99	Kekala, Kanaka H.		2868
		Kahuku		
Dead	Certain			
Nakamura, Mary	9			2867
		Waianae		
Dead	Certain			
Vino, Ignacio	36		35	3162
		KAUAI		
		Haena		
Dead	Certain			
Chew, Leong Y.	73	Chu, Lung Yuen	70,75	2944
Kalani, James C.	1	Kalaui, James; Kalani, child		2937
Kelau, Kale	54	Lelau, Robert		3458
Laanea, Dianua D.	5	Laanea,child,Pakalana,Paalana,Kaalana;Laanae,Pulani	4,6	2943
Laanea, Rosalina P.	0	Laanea,child; Laanea, Puunani; Laanai,Puunani	1	2942
Laanea, Silas	3	Laanea, child; Laanai, Silas	4	2941
Lindsey, Vickie K.	7	Lindsey, Vickie T., Vicky; Lindsay, Tina	2,4	2938
Dead	Possible			
Laanea, Gwendolyn	9			
Missing	Possible			
Kalani, child				
		Wainiha		
Dead	Certain			
Puulei, Gwendolyn	0	Puulei, child, Kena, Keao, Keoa	3	2940
Puulei, Helen M.	1	Puulei, child; Puulei,Sarah	2	2932
Puulei, Robert J.	2	Puulei, child	3	3457

Name	Age	Variant names	Var. ages	Death cert.
1946 tsunami, Kauai, cont.				
		Kalihiwai		
Dead	Certain			
Kaiawe, Akau	61	Keawe, Akau, James A.	70	2936
Lung, Harry Y. H.	25	Lung, Harry Y. F.; Chung, Harry		2797
Lung, Rose L. M.	49	Lung, Mrs. Chang	50,60	2798
Mitsui, Iwa	56	Mitsui, Ewa	57	2934
Ninomoto, Ruth S.	9	Ninamoto, Ruth	10	2935
Missing	Certain			
Lung, Chang	68		70	2946
		Nawiliwili		
Dead	Certain			
Hada, Charles C.	32	Hada, Charles		2916

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Name	Age	Variant names	Var. ages	Death cert.
1960 tsunami, Hawaii, Hilo, Dead, Certain, continued				
Lito, Eugenio	65			1782
Look, James K. K.	30		27	1496
Mabunga, Maria	64	Mabunga, Malaya	68	1498
Masutani, Constance	12		13	1500
Matsumura, Yuriko	37	Matsumura, Mildred		1502
Matsumura, Toshio	39			1501
Merciano, Mariano	62	Marciano, Marceano, Marion,	33	1503
Moniz, Pedro	71	Moniz, Pete		1504
Motomura, Atsushi	37		36	1505
Nakashima, Alvin	6	Nakashima, Elvin		1506
Nakashima, Karl	10	Nakashima, Carl		1507
Namauu, George	19			1508
Omega, Francis B.	34		40	1509
Omega, Robert	29			1510
Ota, Lynn A.	10		8	1511
Ota, Wakino	72		68	1512
Pasilaban, Julian	66	Pasilaban, Julien	75	1783
Sato, Toyoji	69	Sato, Liilii		1513
Sea, Maria L.	89	Sea, Maria I.		1514
Segundo, Jaime	69		50	1784
Shimazu, Daisy S.	35	Shimazu, Mrs. Shizuko	36	1516
Shimazu, Nick M.	47		40	1517
Tabing, Gary Y.	3			1520
Taniguchi, Mrs. Yumi	78	Taniguchi, Mrs. Yuma		1521
Topley, Arthur	62	Tarpley, Arthur		1523
Tsunoda, Masanosuke	74			1810
Wailani, John	67			1785
Yamamoto, Chuichi	72			1524
Yamamoto, Etsuko	45	Yamamoto, Itsuko	58	1525
Yoshioka, Suezi	79	Yoshioka, Sueci, Sueji	71	1526
Dead Possible				
DeMello, Mary	25			
Missing Probable				
Bas, Rufino	72			
Shimazu, Brian H.	9			
Shimazu, Mrs. Kishi	70			
Shimazu, Rachel M.	6			

TSUNAMI OF NOVEMBER 1975

HAWAII

Halape

Dead Certain

James A. Mitchell (Search not made in this study for death certificate)
Michael Cruz (" " " " " " " " " ")